The AMSAT® Journal

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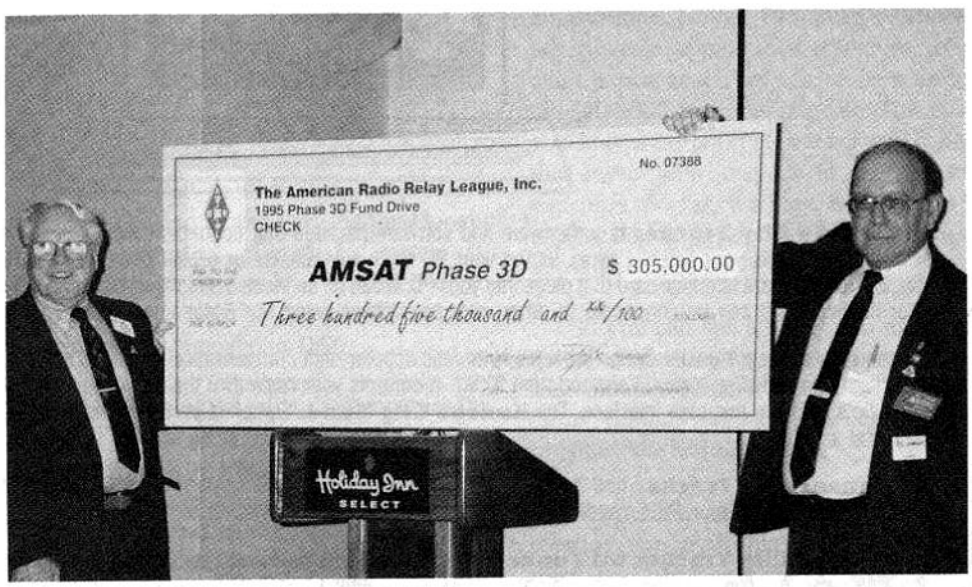

Bill Burden, WB1BRE, ARRL New England Director (R) presents AMSAT-NA President Bill Tynan, W3XO (L) with a check for $305,000 at the recent AMSAT Symposium Banquet in Orlando, Florida. The proceeds were from the latest ARRL Phase 3D fund raising campaign. A previous ARRL fund-raiser netted over $200,000 for Phase 3D. The latest check brings ARRL's total Phase 3D financial support to well over half a million dollars. (AMSAT-NA Photo by Keith Baker, KB1SF)

Launch Contract for Phase 3D Finalized

Dr. Karl Meinzer, DJ4ZC, AMSAT-DL President and Phase 3D International Satellite Project Leader, announced on October 7, 1995 that all major contractual issues for the launch of the satellite are now complete. The final details surrounding the agreement for launch of the satellite by the European Space Agency (ESA) were unveiled during a series of formal kick-off meetings held on September 28th and 29th, 1995, at Arianespace Headquarters in Evry, France.

Dr. Meinzer led the negotiations with ESA on behalf of all the AMSAT groups participating in the project. In addition, Keith Baker, KB1SF, AMSAT-NA Executive Vice President and

[continued on page 4]

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The **Kansas City Tuner** Option provides automatic doppler-shift compensation for digital satellite work. The **Tuner** is compatible with most rigs including Yaesu, Kenwood, and ICOM. It controls your radio thru the radio's serial computer port (if present) or through the radio's up/down mic-click interface. The **Kansas City Tuner** Option is perfect for low-orbit digital satellites like the NOAA and Microstat satellites.

The **Kansas City Tracker** and **Tuner** include custom serial interfaces and do not use your computer's valuable COMM ports. The software runs in your PC's "spare time," letting you run other programs at the same time.

The **Kansas City Tracker** and **Tuner** programs are "Terminate-and-Stay-Resident" programs that attach themselves to DOS and disappear. You can run other DOS programs while your antenna tracks its target and your radios are tuned under computer control. This unique feature is especially useful for digital satellite work; a communications program like PROCOMM can be run while the PC aims your antennas and tunes your radios in its spare time. Status pop-up windows allow the user to review and change current and upcoming radio and antenna parameters. The KC Tracker it compatible with DOS 2.00 or higher.

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The **Kansas City Tracker** and **Kansas City Tuner** are fully compatible with N4HY's QUIKTRAK and with Silicon Solution's GRAFTRAK. These programs can be used to load the **Kansas City Tracker's** tables with more than 50 satellite passes.

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The **Kansas City Tracker** comes complete with special control programs that allow the packet BBS user or control-op to perform automated antenna aiming over an hour, a day, or a week. Your BBS or packet station can be programmed to automatically solicit mail from remote packet sites.

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AMSAT-NA can take your order for a Kansas City Tracker/Tuner or one of many Satellite Tracking software packages that support the KCT, such as Quiktrak, Graftrak, and WiSP for Windows. When you order thru them, they receive a Donation in your name towards the Phase 3D Project. Their telephone number is 301-589-6062.

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Apogee View

by Bill Tynan W3XO

By now all members should have received a letter from me requesting donations to the Phase 3D Project for 1995. The letter, and accompanying status report, makes it clear that the completion and launch of Phase 3D, as well as the continued viability of our organization, depends on everyone being as generous as possible.

The letter also notes that it is especially important that contributions be received before the end of the year, as the Hoover Foundation has offered to match all contributions received by AMSAT up to December 31st. It is not expected that this offer can be renewed in 1996.

From the report which accompanies the letter, you should be able to get a clear picture of how Phase 3D is going. The unfortunate news is that the launch will not take place next spring as had previously been announced. It may not even take place on Ariane 502. That test flight is now scheduled for September, but Phase 3D may not be on it. Nevertheless, ESA has committed to launch us, if not on 502, then on an Ariane 4 vehicle no later than mid-1997. It is currently believed that the most likely timeframe for the Phase 3D launch is probably December 1996.

The report goes into some detail on the status of various hardware items and generally characterizes the Project as being in the "home stretch". It also delves, with considerable depth, into the finances and attempts to explain why, even trying to be as frugal as possible, space hardware costs a lot more than many of us would think. The bottom line is that, even though Phase 3D contributions made directly to AMSAT-NA total approximately $480,000, the ARRL has raised about $500,000 and the European groups have put together another approximately $1.5 million: there is still a question as to whether the Project has enough money to complete and launch the satellite. Based on a launch in 1995, we, here in North America, have budgeted Phase 3D expenditures for next year at about $400,000. From the approximately $1.5 Million they have raised, the Europeans are procuring the solar arrays, batteries and constructing most of the RF hardware as well as many other needed spacecraft subsystems. They are also bearing the brunt of the initial $800,000 launch payment, $210,000 of which we supplied from funds raised by the first ARRL campaign. These expenditures by our European colleagues are severely sapping their resources, so we can't expect much help from them toward the $400,000 we have budgeted. The report also makes the point the we are well behind the curve with respect to income and expenses. So far, we have been forced to deplete AMSAT-NA reserves to the tune of about $185,000.

So you can see why it is so important that all of us do as much as we can to help. The Hoover Foundation is making that easier, for those who get their contributions in before the end of the year.

The minutes of the AMSAT-NA Board meeting appear in this issue. Please read them. I will have more to say about several of the topics covered in the minutes in future *Apogee View* columns. ■

APRtrack Software Now Available

- *WB4APR's recently released **APRtrak** allows the world-wide plotting of stations and objects based on lat/long and grid-squares. It evolved from the Automated Packet Reporting System software which is a packet program for tracking mobiles using GPS interfaced to AX.25.*
- Cost for ***APRtrak** software is:*

- $19 Members (number only)
- $29 Non-members (number only)
- $30 Members (disk)
- $40 Non-members (disk)

- *To order **APRtrak** contact:* **AMSAT-NA at 301-589-6062**

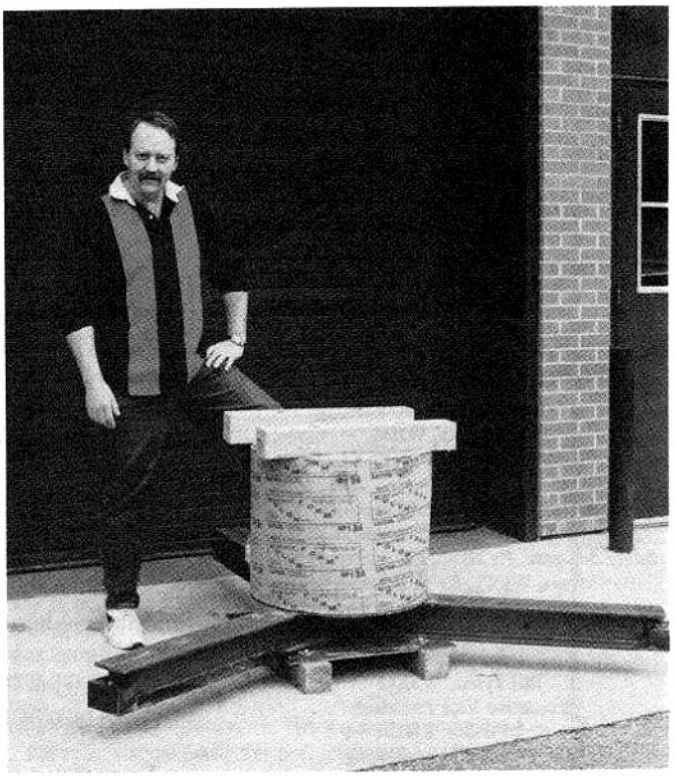
[LAUNCH, Continued from pg. 1]

Dick Jansson, WD4FAB, AMSAT-NA Vice President for Engineering, were present at the Evry meetings and took part in the final contractual and technical discussions with ESA and Arianespace officials.

In his announcement, Dr. Meinzer emphasized that, "This event marks a major milestone in the Phase 3D project as it establishes a firm cost, schedule and technical baseline for our launch. It is clear that the European Space Agency has again recognized the important contributions that AMSAT has made to ESA's work over the years." Dr. Meinzer also highlighted the many provisions favorable to AMSAT in the recently negotiated launch contract when he stated that, "These conditions are all proof that the working relationship between AMSAT and ESA remains mutually beneficial."

The contract calls for a firm launch price of some 1.3 million Deutsche Mark (DM), or about $1 million US, and confirms that Phase 3D's primary launch opportunity will be via the second test flight of ESA's new Ariane 5 booster (Ariane 502). However, if for some reason ESA determines launch via Ariane 502 is not possible, the contract also calls on ESA to exercise their "best efforts" to orbit Phase 3D on an Ariane 4 booster, no later than mid-1997. A recent ESA Press Release announced that Ariane 502 is currently slated for launch in September 1996.

Fortunately, the Phase 3D design team anticipated this eventuality and constructed both the Phase 3D spaceframe and its carrying structure (SBS) to be easily compatible with both the new Ariane 5 vehicle as well as with the venerable Ariane 4 booster. Launching Phase 3D via the Ariane 4 requires an additional adapter ring (to be supplied by ESA) fitted to the bottom of Phase 3D's SBS



Jaim Parsons, Weber State University, poses with the Phase 3D Mass Mockup Unit (MMU) outside the Phase 3D Laboratory in Ogden, Utah. Made from over 1100 pounds of concrete and steel, this ungainly apparatus simulates the exact weight and balance characteristics of a fully configured Phase 3D spacecraft. During recent tests, also done at Weber State, the MMU was successfully used to verify that the Phase 3D spacecraft should separate "cleanly" from its SBS carrying structure during launch. (AMSAT-NA photo by Dick Jansson, WD4FAB)

PacComm

Packet Satellite Modems

PacComm has the most options for 9600 bps satellite work. All built from the G3RUH Direct FM design.

- The MC-NB96 modem card fits any PacComm TNC, or TNC-2 clone to upgrade it to 9600bps.
- The TNC-NB96 is a fully capable 1200 bps AFSK and 9600 bps DFM unit - push button selection of speeds and modes, no cable switching. Supports PacComm's PSK-1 Satellite Modem too.
- The SPRINT-2 High Performance TNC, for 9600 bps and higher. Serial port rates from 4.8 to 56kb. 10 MHz CPU clock speed, 128k RAM. Many other advanced features.
  - Standard model only $225
  - Satellite model allows simultaneous 9.6 uplink and 38.4 downlink for imagery satellites.

PacComm has two ways to go for 1200 bps MicroSat access.

- The PSK-1 Satellite Modem for attachment to most TNCs provides Manchester encoded TX and PSK RX. Add to the TNC-NB96 described above to make an "all mode" packet satellite station.
- The PSK-1T is a PSK-1 with a built-in TINY-2 TNC. As simple to connect as any ordinary TNC.

All our TNCs are "GPS friendly"

- PacComm's unique command set supports GPS position reporting via packet and differential corrections.
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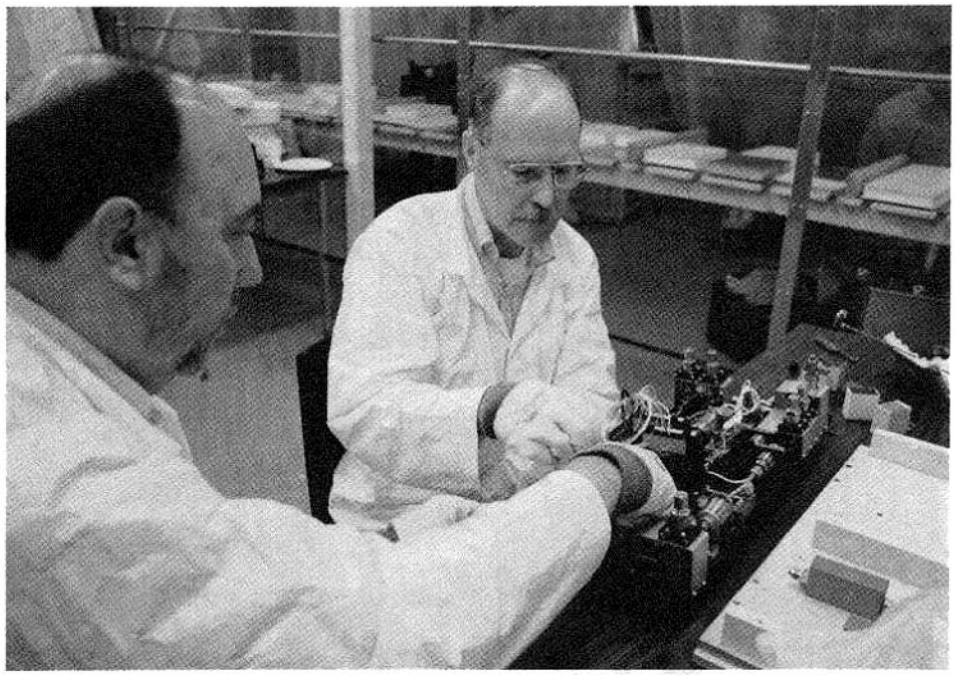
on the Ariane 4's upper stage. The recent meetings in Evry confirmed the feasibility of this approach, and ESA has now developed contingency plans to place Phase 3D in orbit via an upcoming Ariane 4 launch sometime in late 1996 or early 1997 should that become necessary. Preliminary assessments indicate that, other than requiring an additional firing of Phase 3D's 400 Newton kick motor, changing launch vehicles to an Ariane 4 should have little (if any) impact on the satellite's ultimate orbit or planned transponder performance.

While the final negotiated price for Phase 3D's launch is somewhat reduced from earlier estimates, the cost of the launch still represents a sizable sum for an organization such as AMSAT. Fortunately, through the generous contributions of individuals and organizations from around the world, money is now "in hand" to pay the first installment of the launch bill, about 1 million DM (around $800,000 US), by November 1, 1995. This payment will confirm AMSAT's intent to launch Phase 3D with ESA and reserve the launch slot. However, the final installment of the launch bill must still be paid sometime in 1996.

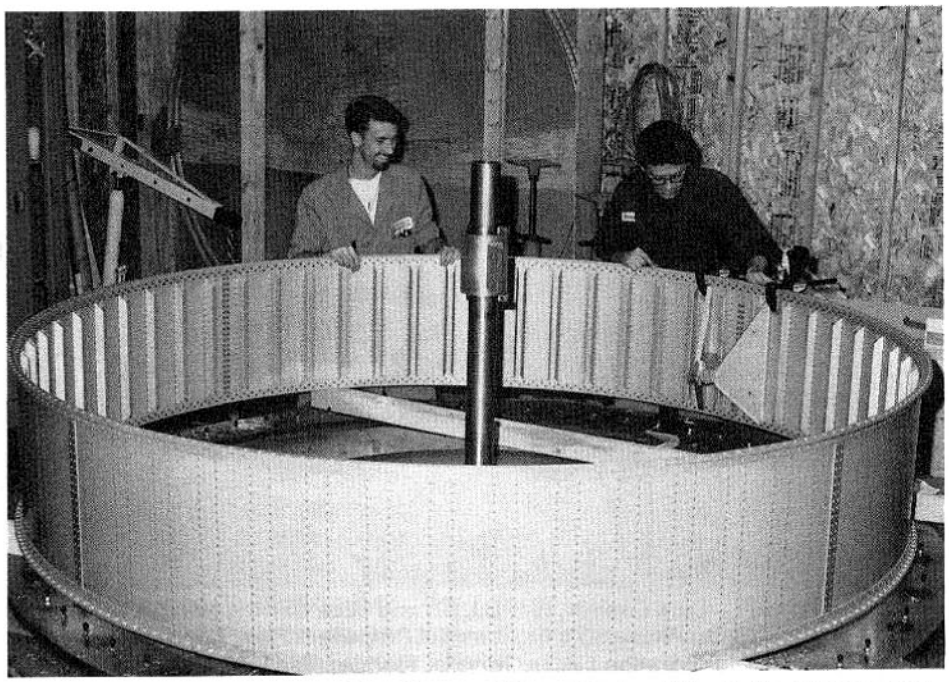
While discussing the overall funding outlook for Phase 3D, AMSAT-NA President Bill Tynan, W3XO, emphasized that, "In addition to the final launch installment, we still need to raise more revenue just to complete the satellite and prepare it for launch. For example, AMSAT anticipates the final assembly checkout, and test of Phase 3D along with conducting the launch campaign will cost an additional $200,000. **These are all expenses that AMSAT does not have current funds to cover."**

"We must continue our efforts to both raise the rest of the funds to complete Phase 3D, as well as to get the spacecraft ready on time," said AMSAT-NA's Keith Baker. Keith went on to note that, "It's clear that ESA fully intends to launch Phase 3D. **Our contract even says that we must provide ESA with our SBS and concrete Phase 3D Mock Up Unit if for some reason our spacecraft isn't ready to go when they are.** While the ball remains firmly in our court to complete Phase 3D in time for launch, I'm confident that we will be ready."

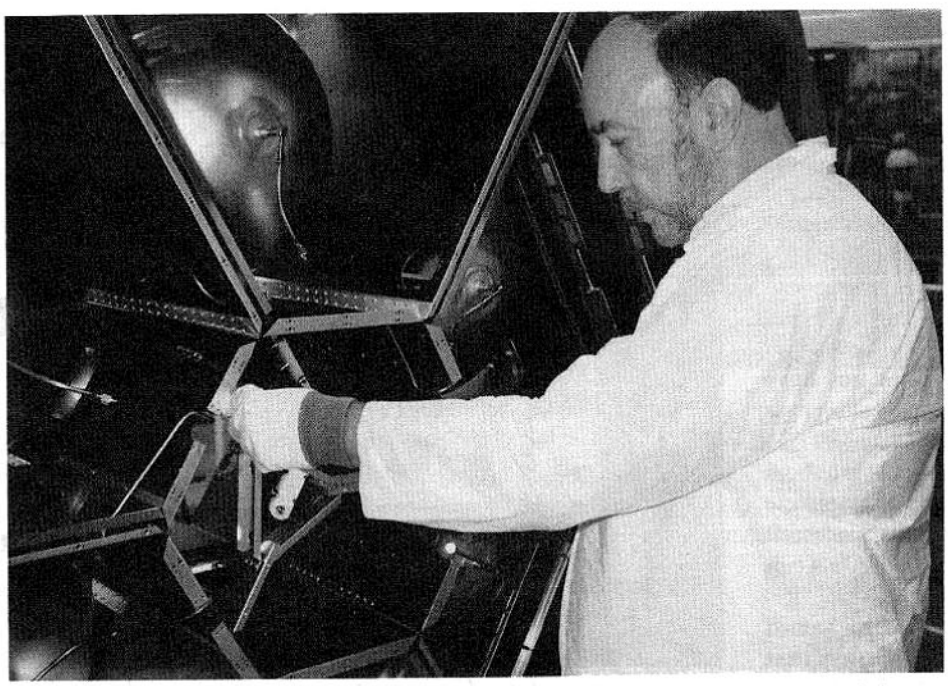


Dick Daniels, W4PUJ, (R) and Mike Garrity, N4OZC, (L) perform minor adjustments to Phase 3D's flight model Propellant Flow Assembly (PFA) in the clean room at the Integration Lab in Orlando, Florida. The PFA will control both the flow of hypergolic propellants to Phase 3D's 400 Newton kick motor as well as the flow of ammonia to the satellite's arc-jet positioning motor. The kick motor will be used to place Phase 3D into its final orbit, and the arc-jet motor will be used to perform minor orbital changes during Phase 3D's expected 15-year lifetime. (AMSAT-NA Photo by Keith Baker, KB1SF)

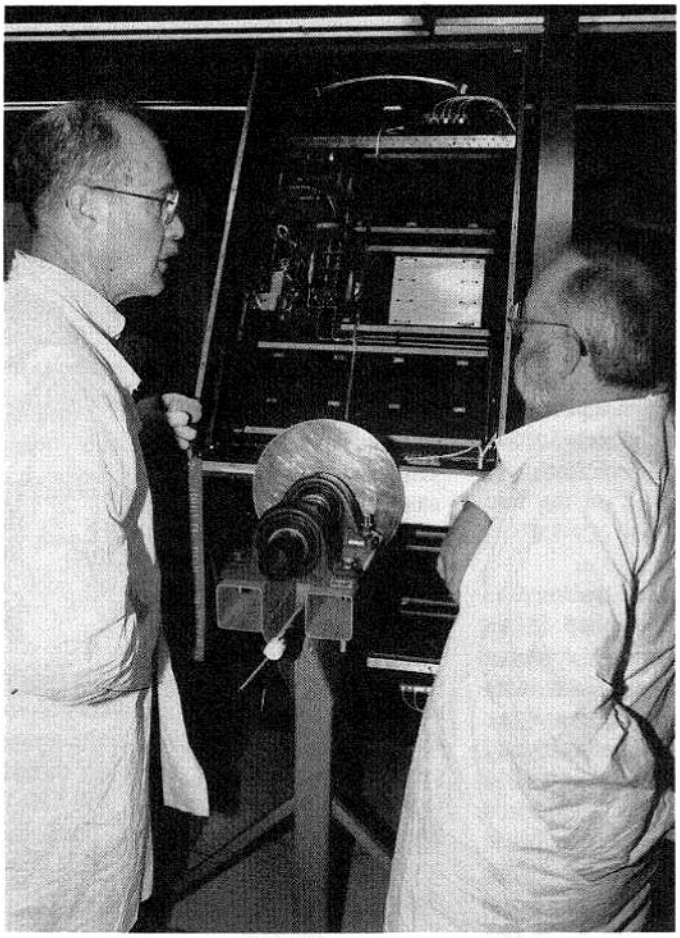
A close-up view of Phase 3D's flight model Propellant Flow Assembly (PFA). Valves and piping on the left side of the unit will used to fuel the spacecraft's hypergolic propellant tanks on the ground prior to launch as well as control the flow of propellants to Phase 3D's 400 Newton kick motor while in orbit. Likewise, valves and piping located on the right side of the PFA will be used to fill the spacecraft's ammonia tanks and, later, will control the flow of ammonia to the satellite's arc-jet positioning motor. (AMSAT-NA Photo by Keith Baker, KB1SF)



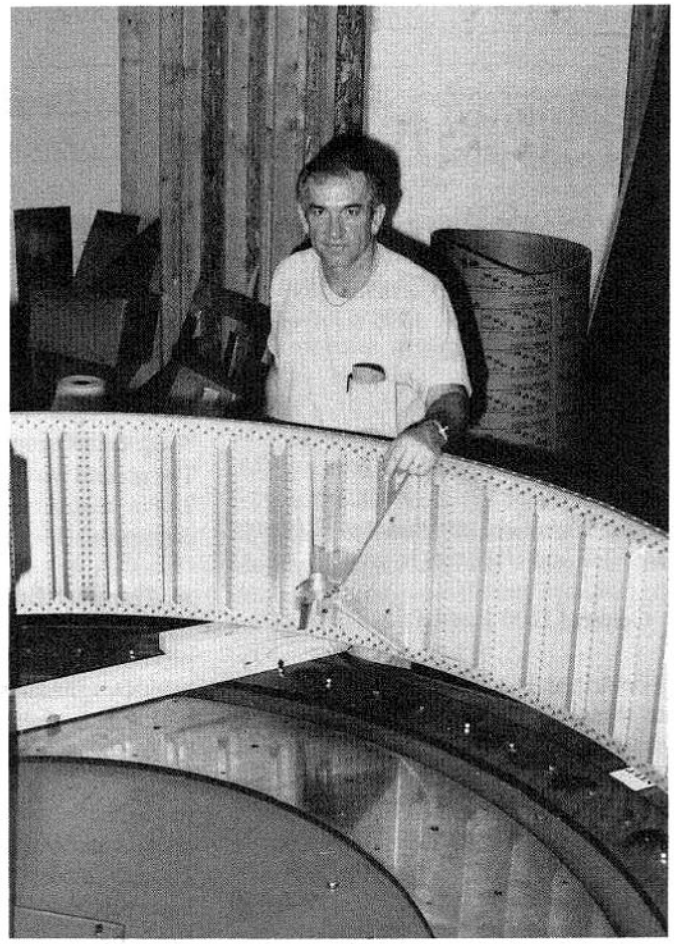
Student Project Co-Leaders Gene Hansen (L) and Richard Vanderford (R) inspect the completed flight model Phase 3D Specific Bearing Structure (SBS) in the Phase 3D Lab at Weber Sate University in Ogden, Utah. The SBS will be used to carry the Phase 3D satellite to orbit aboard its Ariane launch vehicle. (AMSAT-NA Photo by Dick Jansson, WD4FAB)



Mike Garrity, N4OZC, installs the mounting bracket for Phase 3D's arc-jet positioning motor into the "bottom" of the spacecraft structure. (AMSAT-NA Photo by Keith Baker, KB1SF)



Dick Daniels, W4PUJ, (L) discusses placement and operation of the Phase 3D Propellant Flow Assembly with Lou McFadin, W5DID, Phase 3D Integration Manager (R). Portions of the installed power and IF wiring harnesses are also visible in the spacecraft. The curved shaped pipe in the structure near the top of the photo is one of 6 Nutation Dampers that, together with Phase 3D's torquing coils and momentum wheels, will control Phase 3D's attitude while in orbit. (AMSAT-NA Photo by Keith Baker, KB1SF)



Ralph Butler, Project Manager for construction of Phase 3D's Specific Bearing Structure (SBS), poses with the completed flight unit in the Phase 3D Lab at Weber State University, Ogden Utah. One of three separation mountings that will secure the Phase 3D spacecraft inside the SBS during launch is clearly visible directly underneath Ralph's left hand. (AMSAT-NA Photo by Dick Jansson, WD4FAB)

Rules for Using the AMSAT OSCAR QSL Bureau

Walt Rader, WA3DMF, QSL Manager

- The AMSAT QSL Bureau serves the users of all Amateur Radio satellites with a complete QSL Bureau for all Amateur Radio satellite contacts (QSLs other than satellite QSOs will be returned).
- Stations wanting to use the Bureau need only to send three to six #10 S.A.S.E.s (one unit of postage) with your call in the upper left hand corner. DX stations should include enough IRCs for each envelope on file!
- To send your cards through the Bureau, arrange cards ***alphabetically*** by call sign. Stateside cards are free. However, there is a charge of 10 cents per card for all stations outside the U.S. Postal districts.
- Always keep the Bureau informed of any changes in your address or call sign. If you have worked stations with more than one call sign, you should send envelopes for all call signs.
- Mailings from the Bureau will be at the end of each month. All envelopes with ***any*** cards will be mailed at this time. The only exception is if the amateur would like to have their envelope held for a certain number of cards before being mailed. This can be done by writing just below your call sign (in the upper left hand corner) the number of cards desired in the envelope before it is mailed.
- QSL cards that are received at the Bureau when there are no envelopes on file will be held and the Bureau will make an effort to notify the user that he/she has cards on file. If no envelopes are sent to the Bureau within a period of six months, the cards will be ***destroyed***!
- Mailings for DX stations and individual international QSL Bureaus will go out at the end of the month. OSCAR users should also keep envelopes on file at the appropriate ARRL QSL Bureau because most DX cards come to them.
- Questions about the AMSAT OSCAR QSL Bureau should be sent with a S.A.S.E. to the AMSAT QSL Bureau, 3702 Allison Street, Brentwood, MD 20722.

Transmitter and Receiver Modifications For the FT-736 and Other Rigs for Microsat Operation

By Howard Sodja W6SHP w6shp@amsat.org

Editor's note: This article originally appeared in the August 1995 issue of the AMSAT-UK Oscar News.

Although this article gives specific information for the popular Yaesu FT-736 transceiver, general principles and techniques are discussed that apply to many other VHF and UHF rigs as well.

General 1200 Baud PSK Pointers

Getting your rig on 1200 baud PSK is very straightforward. Attempting to use the microphone input and speaker output for PSK operation will work, but the throughput will be disappointing. For best throughput, you must inject and extract the modem's input and output past the pre-emphasis and de-emphasis circuits that shape the transmitted and received audio.

Most newer rigs like the FT-736 have a data jack on the rear panel where you can connect the PSK modem. Owners of older rigs will have to determine where to tap the transmitted data audio (TD) and received data audio (RD) by studying the schematics and locating the most convenient spot to solder the TD and RD shielded cables (1).

Remember to turn the mic gain all the way down during data transmissions as any audio from your microphone will trash your digital signal. After having done this more times than I'd like to admit, and conversely, trying to call stations with my mic gain down, I decided to fabricate a dedicated mic cable for digital communications that has no audio line. This mic cable only has the PTT and up/down mic click lines from my modems. Now, if I press my mic's PTT and the transmit LED does not light, I know my mic is disconnected and my rig is set up for a digital mode.

FT-736 PSK Interface

Connect the cable from your modem's transmitted data audio and received data audio to a mini-stereo plug (2). I recommend connecting these TD/RD lines through a stereo switch so you can conveniently change modes or rigs, as discussed later in this article. Connect a shielded 4 line cable from your modem to the mic connector. The modem cable's PTT line goes to the mic connector's pin 6, the "freq. up" goes to mic connector pin 1, and "freq. down" goes to mic connector pin 3. The ground wire goes to mic connector pin 7. Pin numbers are marked on the mic connector.

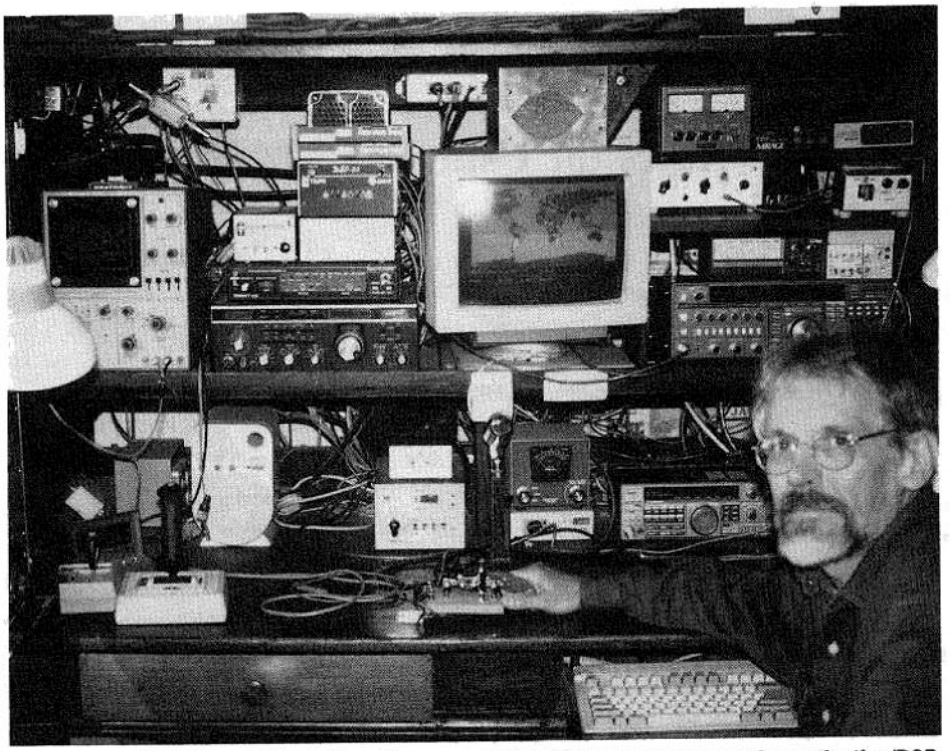
The mic-click frequency up/down is activated when +5 volts is applied. [Most rigs other than Yaesu activate the up/down lines by grounding.] Your PSK modem needs to be internally jumpered or your DSP software modified so that +5 volts, and not ground, is supplied for mic click frequency control. Your modem's documentation should discuss how this is done. CAT frequency control does not work very well with 1200 baud PSK's narrow band signal. Mic click tuning gives you more accurate doppler tracking because of the smaller tuning steps and more frequent frequency adjustments which are determined by feedback from the PSK signal.

General 9600 Baud Modification Pointers

The digital data input/output jacks on the FT-736 and other rigs work fine for 1200 PSK, but not for 9600 baud FSK. Here minor surgery is needed. This can be easily done if you take your time and double check everything.

You must inject the modem's output TD to the FM varactor, and pick up the receiver's RD signal from the discriminator. Use shielded cable such as RG174/U mini-coax. Look for the first resistor after these devices. Solder the coax center conductor to the side of this resistor that is the farthest from the varactor and discriminator, and the shield to the nearest ground point. If you cannot solder directly to the resistor's wire lead, you will have to find another convenient tap point that provides a direct connection to this point, such as an IC pin or transistor lead (1).

If you cannot find a tap point that puts a resistor between the discriminator and the RD cable, add a small 3.3k to 4.7k ohm resistor from the discriminator to the coax



The author, W6SHP, and his station. The upper left modem stack, with modem selection/DSP mode switches, DSP-93 modem, TAPR 1200 baud PSK modem, 9600 baud G3RUH modem, and PK-232 modem/tnc, are discussed in this article. The lower left stack on the table, the FT-736 CAT interface, automatic/manual power control relay switches, and Trakbox, provide fully automatic satellite station control of power, antenna pointing and doppler tuning.

center conductor. A 10k ohm resistor should work fine between the varactor and TD coax. This will usually work if you have a "true FM", and not a phase-modulated rig. The reason for tapping after these resistors is that you do not want load the varactor and discriminator by connecting the modem directly to them.

Many users report that, if left connected, the modem's low impedance causes distortion when using voice modulation. I added a switch to disconnect my FSK TD line. If you do not want to disconnect your modem's FSK TD line with a switch, you can add a resistor of up to 22k ohm in series with your FSK TD line and increase your modem's output to achieve 3 kHz deviation. Experiment to find the best value for your gear.

Decide how you want your rig's FSK TD/RD cables to mechanically connect to your modem. Some just stick the FSK interface cables out through any cabinet opening and let it dangle with a connector attached. I preferred to drill a hole in the rear panel so I could mount another mini-stereo jack near my 736's PSK jack. If you do this, be sure to position your rig so drill shavings will fall out of the rig, and use masking tape to secure rags over the rig's innards to catch any metal shavings that may fly off in unexpected directions. Place a scrap of wood inside, behind where the drill will come out, so the drill will hit wood and not an internal component when it comes through the rear panel. Drill at a slower than normal speed, and you will have no problems. Do not be in a hurry. Do not forget to unplug your AC line before you remove your cabinet covers, or you may be modified!

FT-736 9600 baud modification

You will need to remove the 736's handle and top and bottom covers. Be careful when you remove the top cover to not break the wire that runs from the top cover mounted speaker to connector J16. You can easily disconnect the speaker at this connector.

The RX Unit is the vertical module on the left. Locate R91. It is a 3.3k resistor that is mounted on end, near 2 glass diodes and the square IF can TO09. It is located about 1" (2.5cm) from the top and 3 3/4" (9.5cm) from the rear. Carefully scrape the paint off the wire on the resistor's upper end and tin it. Solder the center of a length of mini-coax to this tinned resistor wire, and its shield to nearby IF can TO09. If you do not want to solder the shield to the IF can, you could use the nearby pcb mounting screw. A solder lug on the coax shield can be easily secured under this screw. Solder the other end to the connector you installed on the rear of the 736 (3).

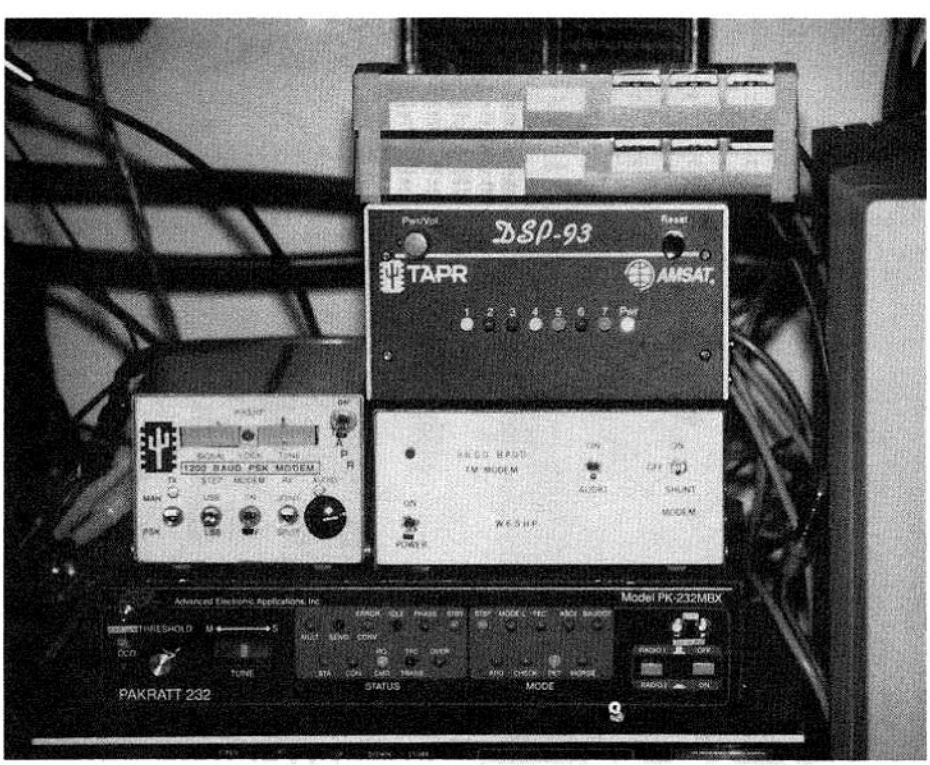
Locate C82, a .01uF ceramic capacitor which is next to rectangular CD01, between R91 and R86. Rock C82 back and forth until it breaks off. Removing this audio shaping capacitor will improve your throughput and audio fidelity by making the audio response flatter.

The TX Unit is the module flat on the left (not the one tucked down the side vertically). Locate R32, a 10k resistor just to the left of the rectangular shielded enclosure (about 2 1/4" (6 cm) from the front metal plate, 2" (5 cm) from the side). Carefully scrape the paint off the wire on the resistor's upper end and tin it. Solder the center of another length of mini-coax to this tinned resistor wire, and its shield to nearby rectangular shielded enclosure. There is a convenient unused screw hole in the shielded enclosure where you can insert and solder the cable's shield. Solder the other end of the mini-coax to the connector you installed on the back of the 736. You can route this mini-coax through the hole in the metal frame by JO7 on the receiver module (near your FSK RX tap), so the cable will not be pinched with the covers on.

DSP-2232 modifications

I have observed many messages on the Microsats reporting that the G3RUH modification for 9600 baud with the FT-736 does not provide enough drive for 3 kHz deviation (4). Some also reported poor receiver sensitivity. I sent out a query to everyone who had this problem. I got several replies, and they all were using AEA's DSP-2232. I also got replies from Kenwood and Icom users who experienced similar problems, again using the DSP-2232.

Some resolved this problem by taping directly to the varactor, which apparently works with the DSP-2232. But this is not a good solution as you will not have any isolation if you use another modem, as the varactor will be loaded. A better solution is



Modem stack at W6SHP, with mode switches on top of DSP-93, TAPR 1200 baud PSK modem, 9600 baud G3RUH modem, and PK-232 modem/tnc.

to fix the source of the problem by modifying the resistor bridges that are in the DSP-2232's TD's output and RD's input.

Users reported that the TD output can be adequately increased by either jumpering port 1's R203 and port 2's R205, or by lifting the ground end of port 1's R201 and port 2's R205. Receiver sensitivity can be increased by lowering the resistance of port 1's R161 and port 2's R210 by paralleling it with another 30.1 K ohm resistor.

G3RUH modem modifications

Your received sensitivity can be increased by changing this modem's input blocking capacitor, C25, from .01uF to a 1uF tantalum capacitor. Another useful modification for this and other 9600 baud modems is to install a mini-stereo jack that is wired to the modem's eye pattern test points. The "eye pattern" test is useful for evaluating your modem's received signal quality. This test has been invaluable for me as I could see if modifications I was making to my rig and modem were improving my 9600 baud downlink signal quality. Inaudible QRM that was occasionally ruining my throughput was also found by viewing the "eye" pattern.

Modem to radio interface cable planning

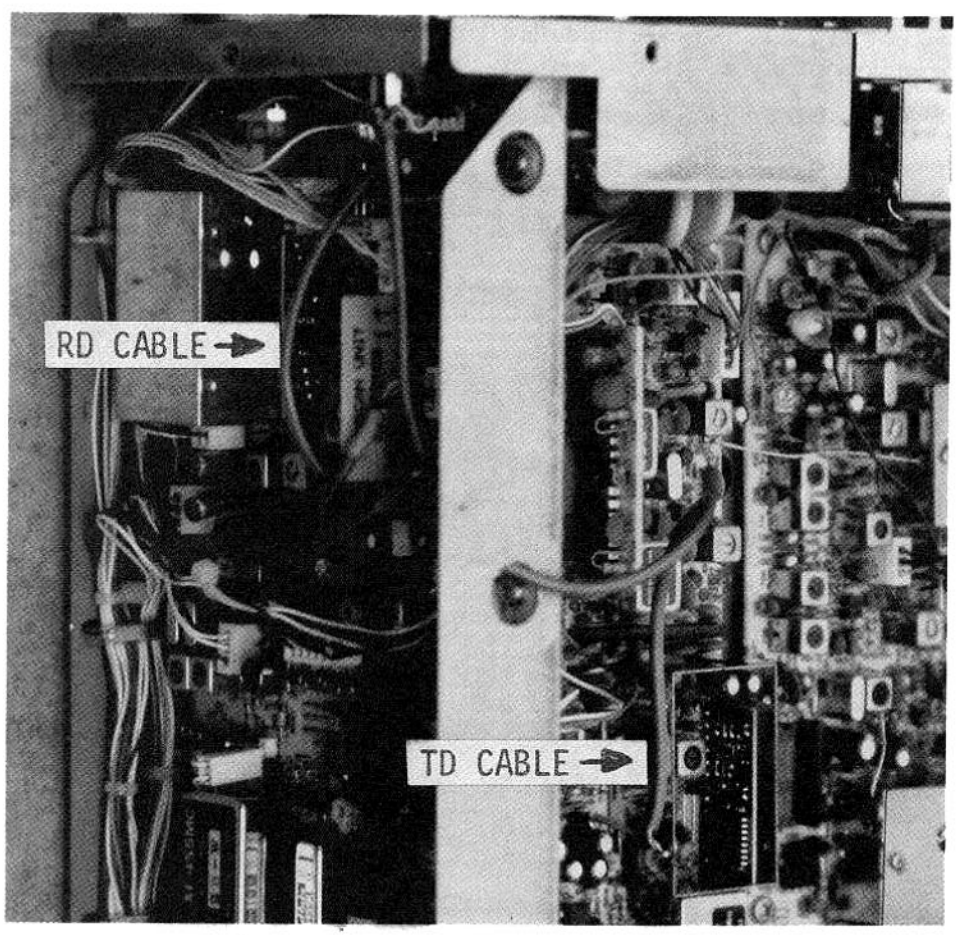
You should plan your cabling to have the most operational flexibility using all your available modes, whether that means switching between your modems (PSK, FSK, terrestrial packet, HF RTTY/AMTOR, etc.), or routing your DSP's cables to various RD, TD and analog sources.

It is best to construct multi-line cables from your modems and rigs that end by splicing into individual short TD and RD audio cables that terminate in male RCA plugs. These lines can then be connected to 2 or 3 pole RCA TV video/audio source switches so you can switch your TD, RD (and PTT line if needed) between your PSK/AFSK and FSK in/out connectors on your rig, or to other rigs or modems. Lines that may not always be used, such as the "aux" line in the DSP-93, should have an in-line female RCA connector so it can safely flop around without shorting to anything, and can be easily connected to a standard RCA audio cable for use with other DSP functions, such as the scope or signal generator. A 4 line shielded cable with mic click frequency up/down and PTT lines that will go to your mic connector should be spliced at the same junction where your TD and RD lines are spliced out of your modem's cable.

You need to take some time and think through all the operational configurations you will want now and may want in the future, as it is much easier to add extra cables you do not need now but probably will in the future, than to splice them in later. Draw a cable and switching schematic that gives you these options using 2 or 3 pole RCA TV source switches. By changing my mic cable, two 3 pole/3 throw RCA TV switches and one 2 pole/3 throw RCA switch I am able to interface my G3RUH FSK, TAPR PSK, TAPR DSP-93 and PK-232 modems to my FT-736, and my TAPR DSP-93 modem to my TS-440 for both digital communications and DSP filtering of HF analog signals, or use either rig for normal CW or voice communications. I typed a "mode check list" on self adhesive mail labels and stuck one on every switch to assure each switch is correctly set when I change modes.

Double check the pin-out of all your connectors before you solder, as it is easy to get female and male pin number sequences reversed. Mini-DIN connector pinouts are not obvious or sequential. From reading the mail on the birds and on the Internet it appears this is the most common reason why digital systems do not work the first time they are tested. One incorrect line is all you need for your system to not work (5).

If you have a DSP that will not be using its second radio port for an HF radio, you could use one port for PSK/AFSK and the other for FSK, to simplify your wiring. This would also permit fully automated operation on both PSK and FSK as no stereo switch will be needed to change modes,



FT-736 interior, front view. Transmitter module is on top and the receiver module is on the side. The receiver's discriminator tap is not visible, behind the receiver module's frame, near the hole used for routing the TD cable.

unless you want to disconnect your FSK line for voice operation.

Modem Cable Construction

Use heat-shrink tubing over each sliced wire so that the spliced wires are slim and well insulated from each other. Once all the wires are spliced, bundle them all together so they are neatly side by side with all their shields lying together, pointing 90 degrees from the bundled cables. Secure all these cables together with a self locking nylon cable tie just beyond the exposed outer shields, where all the spliced cables lie together and the cable outer coverings are uncut. Then twist all these shields together and solder them so they are electrically and mechanically one common thick shield, sticking up from the bundled cables. Now squeeze the spliced wires tightly together with 2 or 3 snug wraps of thin vinyl electrical tape.

Stick the shield from the modem's multi-wire cable up and twist it to make it into a thick wire and tin. Wrap the tapped splices with aluminum foil, overlapping the shielded cables on both ends onto the uncut cable ends. Then wrap solid bare tinned wire around one cable shield end, then around the foil, and then onto the other cable shield end. Solder this connecting ground wire to both shield ends and press this wire and shielding snug against the foil. Wrap another layer of foil over these shields and connecting wire, overlapping 3/8 to 1/2 inch onto the uncut cables at both ends. Now tightly wrap a couple of layers of vinyl tape over this foil shielding, overlapping the foil at both ends onto the cables' outer jackets, and secure the tape end and cables at the end where all the bundled cables are secured together with another self-locking nylon cable tie. The first cable tie should be taped over, so only the last cable tie is visible. The resulting splice will be mechanically and electrically solid, RF tight, and look good.

Adjusting Deviation

The best way to adjust the deviation of your modem's TD signal is with an FM deviation meter. If your modem has a continuous output, such as the G3RUH modem, activate your transmitter. If your modem only transmits output when it sends packets, such as the DSP-93, load your terminal program and set your TNC to UNPROTO so you can send unconnected packets. Hold any key down and you will see bursts of data being transmitted. Adjust your modem's TD level for 3 kHz deviation. Use an insulated tuning wand to adjust the modem. If you accidentally slip and drop a metal screwdriver inside the modem, you may cause shorts that could result in serious electrical damage. I slipped once while adjusting my DSP-93. My heart stopped as I saw DSP status lights flash that should not have been flashing, as my screwdriver bounced on the circuit board. My system locked up and nothing worked, not even the reset button. Fortunately a cold reboot got me back on line. But I could just as easily have caused some serious hardware damage.

If you do not have a deviation meter, you may be able to accurately set the deviation with a good scope and a 10:1 scope probe. First transmit an unmodulated carrier and note the DC out of your receiver's discriminator. Make sure there is no modulation on your signal. You may have to turn your modem's TD deviation pot to zero. Re-tune the RX by exactly 1 kHz, and note the voltage change. That gives you the discriminator sensitivity in Volts/kHz. Now send data, and adjust the TX deviation to give +/- 3 kHz using the calibration just achieved.

With the FT736R and other full duplex rigs you can do this by tuning your transmitter to 145 MHz, and the receiver to 435 MHz, where you will hear your third harmonic. After performing the above adjustment, the actual TX deviation will be one-third the indicated value. So whatever TX pk-pk voltage the above test requires, very carefully increase it 3-fold to 9 kHz at 435 MHz (6).

If your scope is very old and does not have the needed stability or resolution for the above test, see if you can find someone who has properly calibrated their deviation with the same rig as yours. Ask them to check their varactor's p-p value. In the FT-736 800 mV p-p gives you about 3 kHz deviation.

Receiver IF Filter Improvements

The standard IF filter that comes with the FT-736 can be used with satisfactory results. The 6 dB IF bandwidth for "FM-N" is 8 kHz. It is necessary to use the wider 15 kHz "FM" mode and make many tuning adjustments during a pass. Automatic downlink Doppler tuning adjustments are required to get optimal throughput, unless you are willing to tune continuously to keep the deviation needle centered. Uplink signal tuning is not as critical as the satellite's uplink receivers have wide front ends and in some cases AFC circuitry. Doppler tuning devices are advertised in the amateur satellite journals.

The FT-736's factory installed filters were designed for optimizing audio, not data. Digital signals are less tolerant of non-linear responses and require a wider audio frequency bandwidth. If you want to optimize your FT-736 for data communications and make tuning less critical, 20 kHz replacement filters are available from Yaesu. (Table 1).

The two IF ceramic filters listed for CF01 are similar, but are from different manufacturers. I changed both XF01 and CF01 from the stock 15 kHz to the above 20 kHz filters. My pb.log's throughput figures disclosed that although my maximum bytes per second did not increase, my gross bytes per second did. This resulted in an average increase of about 100 Kbytes per pass downloaded on UO-22, KO-23 and KO-25 (7). Also, examining my "eye" pattern on my scope I see that I can now keep the eye fully open while I tune my 736's discriminator needle from one end to the other of the meter's dark center area. With the 15 kHz filters only the

Table 1 - 20 kHz Replacement Filters

PCB component-function	Device	Yaesu Part #
XF01 - IF front end crystal filter	13M-20A	H1102126
CF01 - FM ceramic IF filter	CWF455D	H3900203
	LFH20S	H3900205

left half of this center area could be tuned without degrading my "eye".

Yaesu assured me 20 kHz filters would not compromise cw, ssb and voice FM operation as other filters are selected for these modes. The Yaesu tech also confirmed that a filter wider than 20 kHz would not increase throughput at 9600 baud FSK, but it would make tuning less critical.

If you want to widen your IF bandwidth and you are unable to purchase a wider filter, you can remove CF01 and replace it with a .01uF capacitor. Connect the capacitor between the two solder pads which are ***not*** connected to ground. Your first IF filter, XF01, will now set your bandwidth. With the factory installed 15 kHz first IF filter you will get about 12 to 14 kHz at -6 dB, and 24 to 26 kHz at -60 dB. Both the stopband rejection and the filter slope are slightly degraded, but the performance at 9600 baud is much better then with CF01 in place (8).

Credits

I'd like to thank everyone who has provided me with information and feedback for this article. Thank you, Patrick F1TFQ, James G3RUH, Dave G7HCE, Jim K6OYY, Bill N7RYW, Tom NW5B, Ron W5RKN, Reid WA4UPD, Gary WB2PSI, Jean VE2KAD, and Manfred XQ2FOD.

Footnotes and References

1. Before you do any modification, call your rig's manufacturer to see if they have a service bulletin for 1200 baud PSK and 9600 baud FSK modifications. Other sources for this information are the various AMSAT nets, and the AMSAT-BB discussion group on the Internet. You can subscribe to the AMSAT-BB discussion group by sending a subscription request to listserv@amsat.org.

2. In some Yaesu manuals data in/out jack pins are listed in reverse of what they actually are. The mini-stereo tip is the received data (RD) and the ring is transmitted data (TD).

3. My 9600 baud modifications are based on a bulletin by James Miller, G3RUH. I expanded on this information based on my own experimentation and from messages from other users.

4. I received reports that R91 has been mounted in reverse on some production runs, so that the discriminator must be tapped at pin 10 on the RX module's FM scanner board. Yaesu assured me this has never been the case. Although Pin 10, which comes directly from the discriminator, reportedly works for DSP-2232 users, the recommended tap is on R91's side opposite the discriminator, as discussed above.

5. Pin-outs for the CAT port was in error in some FT-736R manuals and in an old Yaesu "Application Note". The correct pins are Pin 1- Ground, Pin 2- Serial Data In, Pin 3- Radio Port Busy, Pin 4-Serial Data Out, Pin 5- No Connection, and Pin 6-13.8 volts.

Note that the pins are not numbered sequentially:

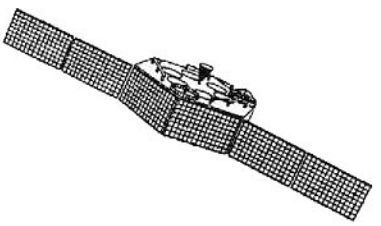
3 1
6
5 4
2

(rear view of male plug)

6. This method of setting deviation was suggested by James Miller, G3RUH.

7. PBLOGNEW.EXE by Patrick, F1TFQ was used to statistically analyze my throughput from my pb.log files for UO-22, KO-23 and KO-25. This file was downloaded from KO-23.

8. Modification and performance evaluation by Manfred, XQ2FOD. He can be contacted on KO-23 and KO-25. ■



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AMSAT-NA President Emeritus Tom Clark, W3IWI (R) was presented the Moe I. Schneebaum Award for Engineering by Joseph Rothenberg (L), Director of the NASA Goddard Space Flight Center. Dr. Clark was honored for his sustained and innovative contributions to RF/microwave antenna, receiver and signal-processing technologies, especially as they relate to precise geodetic measurements using Very Long Baseline Interferometry (VLBI) and the Global Positioning System (GPS), and for developments in low-cost spacecraft technology. Tom recently developed an inexpensive GPS-based "Totally Accurate Clock" which outperforms more expensive commercial units and is also used by many AMSAT members in various applications.

Bill Burden, WB1BRE, ARRL New England Director (L) presents Dick Jansson, WD4FAB, AMSAT-NA Vice President for Engineering (R), with the ARRL's Technical Merit Award. Dick was cited by the League for his "work on amateur satellites, principally in the area of spacecraft mechanical and thermal design." The award was presented at AMSAT's 1995 Annual Meeting and Space Craft Symposium held in Orlando, Florida in early October. (AMSAT-NA photo by Keith Baker, KB1SF)

Amateur Satellite Computer BBSs

Alabama

The WireNet BBS, 205-444-9638
NASA Spacelink, 205-895-0028

California

OCA/AMSAT BBS, 714-738-4331
Western Pacific BBS, 415-453-2854

Colorado

The Communications Ctr, 303-278-4075

Connecticut

The ARRL BBS, 203-666-0578

Georgia

Top of the Rock BBS, 404-921-8687

Illinois

QCBBS, 309-797-3827

Maryland

PC-Ham BBS, 301-593-9097
NASA OIG RAID, 301-262-6784

Massachusetts

The Radio Room, 617-233-4940

Minnesota

HAM >LINK< BBS, 612-426-0000

New York

Ham-It-Up BBS, 516-878-4906

New Jersey

AMSAT Sats & Stats, 201-261-2780

Ohio

Celestial RCP/M BBS, 513-427-0674

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Dallas Remote Imaging Grp, 214-492-7057
Zachary Net, 713-933-7353
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The Amateur Radio Space Experiment SAFEX II

RR0DL - A New Amateur Radio Station on MIR

by Thomas Kieselbach, DL2MDE
(Translated by John Bubbers, W1GYU)

Editors Note: The following article originally appeared in CQ DL, the Deutscher Amateur Radio Club (DARC) magazine. The article has been slightly revised to reflect recent SAFEX II changes.

The international Amateur Radio community always tries to use the manned space flight missions. Thus far, this has occurred on several American and Russian space missions. Years ago, the Russians installed an Amateur Radio station on MIR. This station operates on the 145 MHz band in voice and packet modes. After the Russian-German MIR-92 space operation, it was proposed to expand the existing equipment in order to accommodate current communication technologies. The launch is now planned for spring 1996.

An agreement was made in February 1994 between NPO Energia, Russian radio amateurs, DARC, and the Ham Radio Group at the German Aerospace Research Establishment (DLR) to install a new Amateur Radio system on MIR. This system will be mounted to the *Priroda* module and will be comprised of various components which operate on different Amateur Radio bands. On the German side, support was given by the Deutsche Agentur fuer Raumfahrtangelegenheiten (DARA). SAFEX II is cost shared, whereby the DARA & DARC cover development and fabrication expenses, and the Russians incur installation and operation expenses.

The system is comprised of two main parts with auxiliary equipment:

- Radio equipment in the 430 MHz amateur band (2.2 MHz Duplex Offset).
- Radio equipment in the L/S band (Uplink 1265 MHz/Downlink 2410 MHz).

The first part is devoted to Amateur Radio communication needs and the second part is for future experiments.

History

In the past, there has been Amateur Radio involvement on the following German missions:

- 1985: DP0SL on the first German Space-Lab-Mission;
- 1992: DP1MIR on the Russian-German Mission MIR-92;
- 1993: DP0SL on the second German Space-Lab-Mission;
- 1994: DP3MIR on the Russian-ESA Euromir 94;
- 1995: DP0MIR on the Russian-ESA Euromir 95.

In 1993, first discussions and negotiations with the Russian partners (NPO Energia) and the Russian radio amateurs took place, which led to an agreement in March 1994 concerning a new Amateur Radio station on MIR. In May 1994, DARA promised to participate in financing the project. In August 1994 an agreement between the partners was signed for the start of RR0DL in late summer 1995 (postponed to spring 1996).

Project Requirements

The experience of earlier missions showed that astronauts and cosmonauts are very busy and overloaded with work. Therefore new equipment must offer technical arrangements which permit Amateur Radio activity without active crew operation. Since Amateur Radio operators have interests in many technical areas, SAFEX II equipment will satisfy both communication and experimental needs.

Russian requirements for flying SAFEX II had to be fulfilled in detail, but they were very generous. This can be seen by a 30 kilograms payload, three external antennas, and an electrical power of 50 Watts/24 hours, with peaks up to 300 Watts for a maximum for two hours/day. The technical demands for all parts of the equipment are very high. What does not correspond is not going to be launched. In addition a tight timetable had to be established before realization of the project.

Concept

The equipment for RR0DL consists of two main parts with several additional devices. Radio equipment in the 430 MHz band: Duplex with a 2.2 MHz frequency offset, modified as a MIR crew communications system; radio equipment in the L/S-Band: 23-cm uplink, 12-cm downlink, designed as an experimental system, transponder operation, amateur television (ATV), and future experiments.

Presently, a 2-meter Amateur Radio station exists on MIR. It is, however, installed in another MIR module. It is also planned to install a 144 MHz radio which will be switched by a diplexer in order to make operation possible from RR0DL on 2-meters or crossband.

430 MHz Equipment

To a large extent, the 430 MHz installation corresponds to FM repeater technology using an ICOM 4020 that has the following modifications:

- Diplex filter and switches for 2-meters
- 70-cm filter for duplex-mode
- Packet radio TNC for duplex-digipeater
- Digital voice recorder
- Digital voice identification
- Changeover of the supply voltage to 28 Volts
- Frequency and operating control system/mode control

The device in its original housing (425mm width x 149mm height x 368mm depth) is built for rack mounting and operation by the MIR crew. It is also possible to use this equipment via a remote control from ground stations [Moscow (R3K) and Oberpfaffenhofen (DF0VR)].

Mode-1: Relay Operation

- Downlink: 437.950 MHz;
- Uplink: 435.750 MHz, 2.2 MHz frequency offset;
- CTCSS tone for operation.

While it is possible for MIR FM voice communications to cover Europe, it depends on the users operating habits whether this type of communication can be realized. Radio discipline has first priority. Special ground stations working in undisturbed transmission mode is possible by using special techniques.

Mode-2: Data Transmission (Packet)

- Downlink: 437.975 MHz;
- Uplink: 435.775 MHz, 2.2 MHz frequency offset;
- No CTCSS tone operation.

Previous experience was gathered using packet radio on MIR. The new device operates at 9600 Bd and echoes every data packet. With this concept, a higher data rate than with the former equipment can be achieved by increased data speed and a minimum reduction of packet collisions. There is also a PC lap-top available at the station for mailbox operation.

Mode-3: QSO-Operation of the MIR Crew

- Downlink: 437.925 MHz;
- Uplink: 435.725 MHz, 2.2 MHz frequency offset;
- CTCSS tone for operation.

The cosmonauts can perform normal QSOs and can also carry out special functions using this mode. Certainly in QSO operations, it is very valuable that no other signals are heard on the downlink frequency (communications discipline!).

In addition, the cosmonauts have three other possibilities to use RR0DL:

1. In special cases, a CTCSS tone can be switched to the transmission of RR0DL and DTMF tone can be used. The crew applies this in case they want to contact specific stations. This is planned for emergency use, contacts with control centers and with their families. Ground stations can be equipped accordingly, so that cosmonauts can dial into a telephone system with the DTMF tones in order to reach their XYLs or another OM. If this is noticed other hams should not disturb!

2. Furthermore, a digital voice recorder will be built into RR0DL. With this device, cosmonauts have the possibility to transmit a message world-wide. They record a text on the digital voice recorder and this text will be transmitted at regular intervals for durations up to 2 minutes, with a 2 minute break. DLR added an identical device to the already existing 2-meter equipment. Recent messages transmitted from MIR were New Year's Wishes (1994), Greetings to Ham Fair Friedrichshafen (1994), and during the Euromir 95 Mission.

3. Picture transmission is a new concept for RR0DL. A system was developed for transmitting pictures in the digital form. The crew can take pictures with a still-video camera that can be stored in a PC lap-top. The protocol for picture transmission is AX.25 and pixels are transmitted in peusdo-random kind with system recognition of pictures after only 30 percent transmission. Missing pixels will be mathematically added at the end of transmission. Transmission time for one picture is 3 minutes and amateurs can receive the picture with a normal packet TNC with 9600 baud modem and a special software version of JVFAX (presently not available).

Ground Station for 430 MHz

A normal FM-transceiver with an omni-directional antenna can be used as a ground station with improved and easier operation using 1) directional antennas, 2) computer control for antennas and transceiver, 3) CTCSS equipment, 4) scanner operation for SAFEX II frequencies, and 5) a narrow frequency grid.

It has to be considered that Doppler shift at 430 MHz can be as high as 15 kHz. Special information for receiving equipment will be provided by mailboxes.

L/S-Band Device

This equipment is planned for Amateur Radio experiments. The basic module works as a transponder with a 10 MHz band width, 1265 MHz uplink and 2410 MHz downlink. It is possible to plug different

Project SAFEX II

Space Amateur Funk EXperiment — Amateur Radio Equipment for the Russian Space Station MIR

QRV On:
2 meters: RX and TX (Simplex)
70 cm: RX and TX (Duplex)
23 cm Uplink and 12 cm Downlink: voice, data, picture and ATV transmission

Downlink Frequencies in the 430 MHz Band:
437.925 MHz: Direct frequency with the space station MIR, QSOs with the cosmonauts, picture transmission and automatically transmitted messages from the MIR crew.
437.950 MHz: Repeater (Relay Operation); Voice contacts between ground stations
437.975 MHz: Data transmission; packet radio direct or over greater distances, mailbox operation with store and forward.

The ground stations transmit on a 2.2 MHz lower frequency. Doppler shift can be up to 15 kHz; the correction must be made at the ground station.

Frequencies for the L/S-Band-Equipment

Uplink: 1265 MHz
Downlink: 2410 MHz
Bandwidth: 10 MHz, linear translation or signals of the space station (for example amateur television)

SAFEX-II Mission Dates: Launch in spring 1996 as a permanent service.
Callsign: RR0DL
Weight: up to 30 kg
Power Supply: 50 Watts over a 24 hour period as well as additionally up to 300 Watts for 2 hours from the on-board supply (28 V).
Operation: Under the control of the cosmonauts; additionally remote control is anticipated from Moscow (R3K) and Oberpfaffenhofen (DF0VR). SAFEX-II is a project of the German Amateur Radio Club (DARC) carried out by different groups under project management of the Ham Radio Group at the German Aerospace Research Establishment (DLR) Oberpfaffenhofen.
Project Leader: Thomas Kieselbach, DL2MDE (email: hams.df0vr@dlr.de)

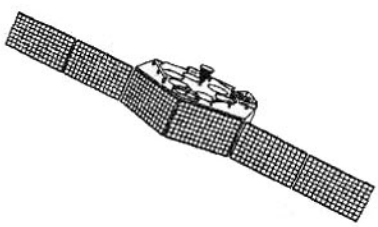
*****

experimental modules into the basic module. The ATV Group at the University of Bremen will develop and build the ATV equipment and also the L/S-band basic part.

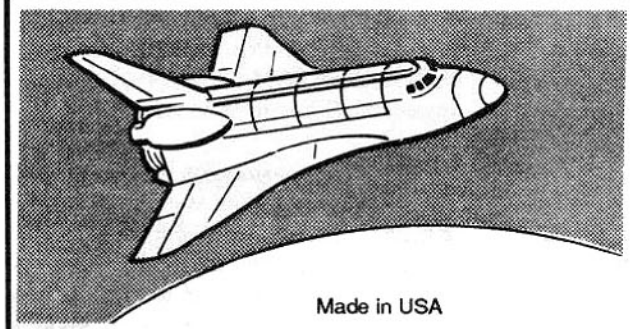
Experimental modules will operate at the intermediate frequency of 70 MHz, the other parameters will be published later.

Conclusions

Additional possibilities for using MIR by the Amateur Radio community have been provided. So now is time to make plans for communications and experiments with MIR! ■



AMATEUR TELEVISION



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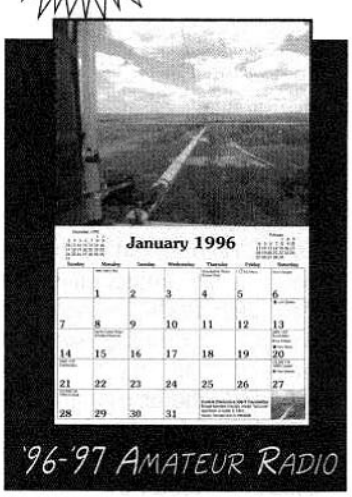

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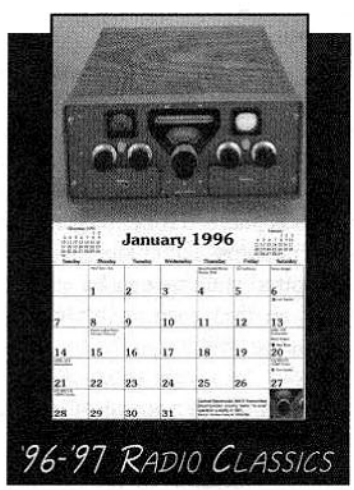

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SAPPHIRE, A University Student Built Satellite for Space Experimentation

Bob Twiggs KE6QMD & Chris Kitts KE6QLL[1]
Department of Aeronautics and Astronautics
Stanford University
[1]**Caelum Research Corporation, NASA Ames Research Center, California**
btwiggs@leland.stanford.edu, kitts@leland.stanford.edu

Abstract

Students of Stanford University's *Satellite Systems Development Laboratory* (SSDL) have been involved in the design and construction of a new microsatellite since April of 1994. This satellite, named the *Stanford Audio Phonic Photographic Infrared Experiment* (SAPPHIRE), has payloads that include miniature infrared (IR) research sensors, a digital camera, and a voice synthesizer. The completed satellite is approximately 40 pounds, 12 inches tall with launch interface, and 17 inches in diameter. It consists of a hexagonal structure with complete processor, communication, power, thermal, and attitude control subsystems.

The SAPPHIRE spacecraft is the first vehicle of the SSDL's new *Satellite Quick Research Testbed* (SQUIRT) program. The goal of this program is to produce student-engineered satellites capable of servicing state-of-the-art research payloads on a yearly basis. Through student participation, voluntary mentors from the industrial and academic community, and the extensive use of off-the-shelf components, the initial cash outlay target for SQUIRT class vehicles is $50,000.

The flight model of SAPPHIRE has been completed and is now in the final testing process. The satellite is expected to be ready for launch after February 1996.

To date, the cost of the components for the satellite has been less than $30,000, and over 70 graduate and undergraduate students have worked on this project. Stanford University is now looking for launch opportunities for this satellite.

The Stanford Audio Phonic Photographic Infrared Experiment (SAPPHIRE)

Based on student interest and the capabilities of the SSDL's affiliated researchers, the selected missions for the SAPPHIRE spacecraft include 1) assessing the performance of experimental IR sensors, 2) performing digital space photography, and 3) transmitting voice synthesized messages.

The IR sensor package is the result of micro machinery research based in Stanford University's Department of Mechanical Engineering and supported by the NASA Jet Propulsion Laboratory. Digital black and white photography is achieved through the modification of a Fotoman camera in cooperation with the engineering staff at Logitech. Digital voice synthesis is obtained through the modification of a commercially available synthesizer board. Messages are transmitted so that they may be received using a hand held radio.

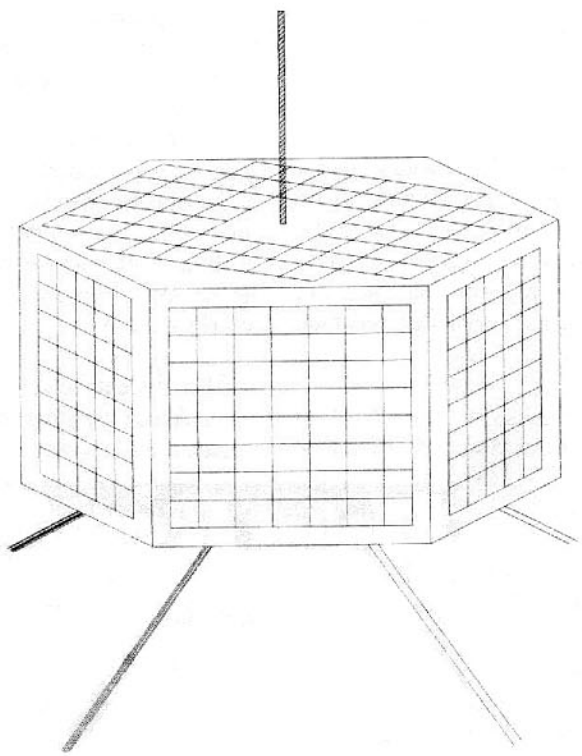

Figure 1 - SQUIRT Physical Form

Structural Subsystem

The SQUIRT structural configuration consists of a right hexagonal prism that is approximately 12 inches tall with launch interface and 17 inches in diameter as depicted in Figure 1. The hexagonal shape was chosen as a compromise between octagonal and rectangular geometries since it balances adequate solar panel exposure and internal volume with manufacturing issues. The external dimensions and vehicle mass were selected to meet eighty-five percent of all secondary launch vehicle opportunities.

Computer, Command, and Data Handling Subsystem

A Motorola 68332 is the baseline processor for SAPPHIRE. The choice was based upon familiarity, capability, cost, ease of interfacing and support, space environment performance, and schedule considerations. Students in a popular design class in the Mechanical Engineering Department gain extensive experience using a Motorola 68HC11 for which all of the development tools are available, thus the selection of the 68332 is a natural extension of their experience.

Communications Subsystem

The communications system provides uplink and downlink data packet transmission and downlink voice and beacon output. Data transmission operates at 1200 baud and is baselined to use AFSK encoding, AX.25 packet protocol, and standard mode J Amateur Radio satellite frequencies. The voice downlink utilizes frequency modulation. The transmitters and receiver are Hamtronics kits that have been optimized for efficiency and operation in space. These kits were found to be the most expedient method to get a transmitter and receiver due to the present experience base of this student group.

The data downlink channel transmits photographic data and spacecraft telemetry. Both packet and voice downlink are broadcast through four antennae mounted to the bottom of the satellite. The downlink transmitter is multiplexed for both the packet and the FM voice synthesizer output.

Orbit and Attitude Subsystem

Orbit and attitude determination requirements specify the ability to take fairly accurate photos of the areas of interest on the Earth. Attitude sensors include student built Earth sensors and a virtual sun sensing system. This sun sensing will occur through the processor's interpretation of solar panel current data. Due to the hexagonal geometry of the panels, a wide arrangement of panel currents may be differentially biased in order to calculate sun position. Initial simulation of this concept suggests that accuracy of about seven degrees may be achieved.

After considering four alternate configurations, a combination of passive magnetic and spin stabilization was chosen. Magnetic control is achieved through the use of permanent magnets mounted to point the camera towards the Earth in the vicinity of the North pole. Hysteresis rods are included to damp oscillations in this motion. This method is one that has been commonly used on other OSCAR satellites.

Power Subsystem

More than eight watts of average power is generated by covering the satellite's exterior with 14% efficiency Gallium Arsenide solar cells. A NiCd battery pack augments the power system during eclipse and high power demand situations. Power conditioning circuitry provides regulated 12V and 5V buses to the satellite components.

The power supply and demand balance is monitored by the spacecraft processor through real-time analysis of power conditioning telemetry. A flight manager software module automatically manages component switching based upon user demand and available power.

Thermal Subsystem

Due to an even solar radiation load caused by the slow spin, the SAPPHIRE spacecraft is able to satisfy all thermal requirements through a completely passive design. With the dedicated assistance of Lockheed engineers and consultation with Dick Jansson, WD4FAB of AMSAT-NA, a detailed thermal model of the spacecraft has been composed and verifies the ability to regulate bus and component temperatures through a judicious choice of thermal coatings and insulation. This model is updated continuously as additional design information is made available.

Ground Station

An OSCAR class amateur satellite ground station is installed on the top floor of Stanford's Durand Building, the home of the SSDL. The configuration of this station will permit the operation of the SAPPHIRE spacecraft, future SQUIRT vehicles, and other SSDL and amateur satellites. The center will be operated and managed by Stanford students, local AMSAT members, and interested local high school pupils. Formal command generation and telemetry analysis will occur in the control center as well as in other SSDL laboratory facilities. Basic mission data formatting and analysis will also be offered by the SSDL. A project is now underway to provide access to this OSCAR station through the World Wide Web.

The students selected Amateur Radio satellite standards in order to foster a cooperative and mutually beneficial relationship with the Amateur Radio community. Current plans call for flight operations

to commence with emphasis placed on payload research and educational activities. During this initial period, moderate access is granted to satellite experimenters and includes command ability for the educational payloads. It is proposed that with research and educational activities finished, complete operational authority of the vehicles will be transferred to the amateur satellite community.

Management and Systems Engineering

As is true with all SQUIRT program spacecraft, SAPPHIRE is a student managed project with faculty and industry mentors acting in an advisory roll. Students developed the requirements for the satellite based on some preliminary specifications and have completed the first flight satellite. They developed tools for project management and have used the Internet and the World Wide Web as a means of communications and documentation.

Present SAPPHIRE Status

The flight model of SAPPHIRE was completed in September 1995 for display and operation at the AIAA/Utah State University Small Satellite Conference in Logan, Utah. At that time students had the opportunity to demonstrate this satellite to a NASA official. SAPPHIRE was also recently demonstrated to AMSAT-NA President Bill Tynan, W3XO, at Stanford University as shown in Photo 1. SAPPHIRE, as shown in Photo 2 with Stanford students, is presently undergoing final thermal, vibration and vacuum tests in preparation for a launch in early 1996.

Additional information on the Stanford satellite design program can be obtained on the World Wide Web page: http://aa.stanford.edu/~ssdl/.

References

- *The Satellite Quick Research Testbed (SQUIRT) Program*, Christopher A. Kitts and Robert J. Twiggs, May 21, 1994, Proceedings of the 8th Annual AIAA/USU Conference on Small Satellites, Logan, Utah, August 29-September 1, 1994. Presented by Christopher A. Kitts and Robert J. Twiggs at the 8th Annual AIAA/USU Conference on Small Satellites, New Missions I Session, Logan, Utah, August 31, 1994.

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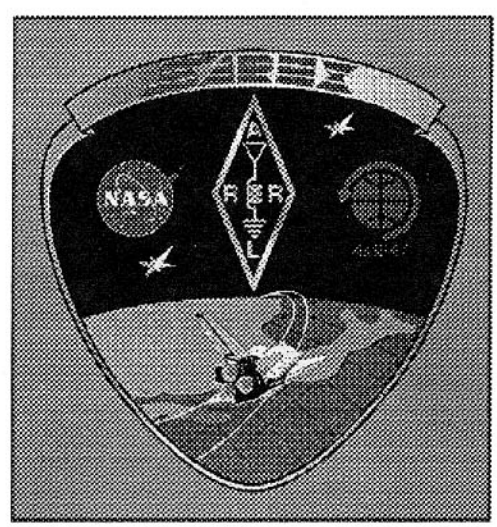

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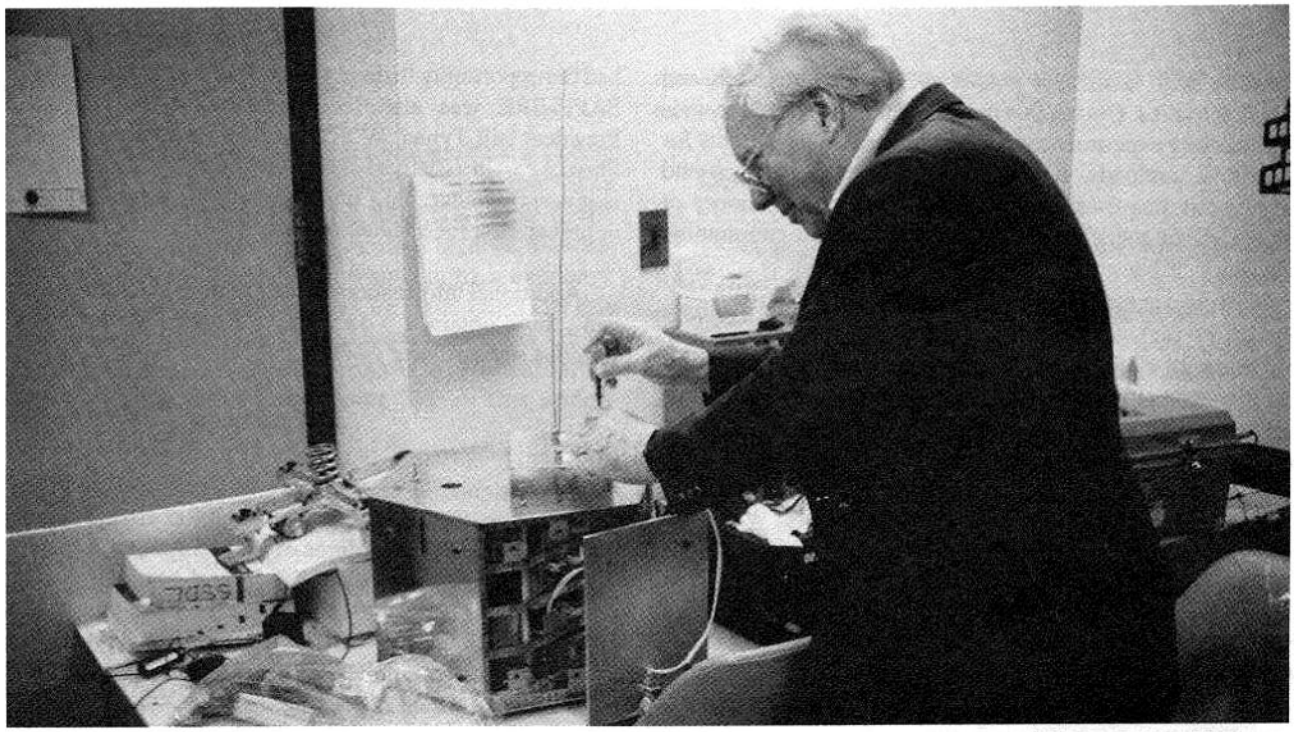

Photo 1 - AMSAT-NA President Bill Tynan, W3XO, puts some final touches on SAPPHIRE at the Satellite Systems Development Laboratory, Stanford University.

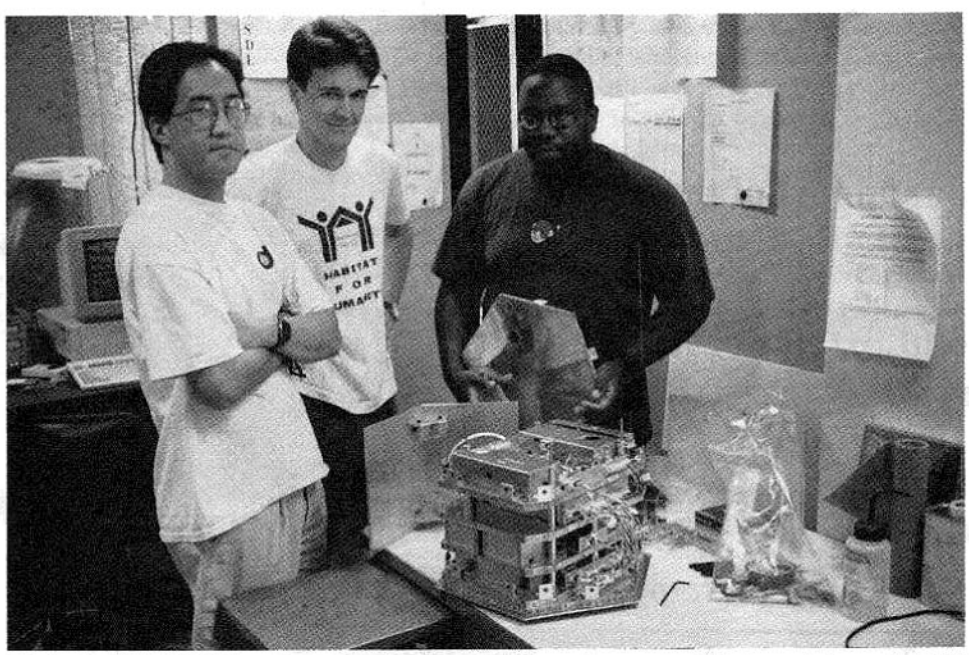

Photo 2 - SAPPHIRE undergoing final preparations for a possible launch in early 1996.

- *The Design and Construction of the Stanford Audio Phonic Photographic Infrared Experiment (SAPPHIRE) Satellite*, Christopher A. Kitts and William H. Kim, May 25, 1994, Proceedings of the 8th Annual AIAA/USU Conference on Small Satellites, Logan, Utah, August 29-September 1, 1994. Presented at the 8th Annual AIAA/USU Conference on Small Satellites, Student Session, Logan, Utah, August 31, 1994. 3rd Place winner in the Student Paper Competition.

- *Investigating the Integrated Control of Payloads with Amateur Satellites*, Christopher Kitts, June 3, 1994, Proceedings of the 1994 AMSAT-NA Space Symposium, Orlando, FL, October 8-10, 1994 and the Proceedings of the 1994 AMSAT-UK Colloquium, Surrey, UK, July 28-31, 1994.

- *Design Progress in the Satellite Quick Research Testbed (SQUIRT) Program*, Christopher A. Kitts and Robert J. Twiggs, , Proceedings of the 9th Annual USU / AIAA Conference on Small Satellites, Logan , UT, September 19-22, 1995. Presented by Christopher A. Kitts and Robert J. Twiggs at the 9th Annual USU / AIAA Conference on Small Satellites, New Missions II Session, Logan, UT, September 22, 1995. ■

AMSAT-NA 13th Space Symposium a Success!

Over 250 participants from 41 states and 13 countries, converged on Orlando's Holiday Inn International Airport to attend AMSAT-NA's 13th Space Symposium and Annual Meeting. During the three-day conference held October 6-8, 1995, over twenty presentations were provided.

On Friday evening, participants were entertained by the following innovative multimedia presentations:

- *Digital Voice Demonstration via the WWW*, Phil Karn, KA9Q
- *The Attempted Launch of UNAMSAT-1; My Experiences in Russia by Video*, David Liberman, XE1TU
- *The North and South Texas Balloon Projects Video*, Doug Howard, KG5OA and Andy MacAllister, WA5ZIB
- *A Slide Show on Satellite DXpeditions in the Pacific*, Mikio Mouri, JA3GEP
- *More Great Pictures of the Heavens Courtesy of the Hubble Telescope*, Dan Schultz, N8FGV
- *AMSAT Net via Commercial Satellite*, Bruce Paige, KK5DO

Other presenters included:

- *Fodtrack Tracking and Tuning Software and Hardware: Software Developed in Chile to Help Fund CEASAR-1*, Ignacio Martinez, CE2MH
- *Progress Towards the Launch of SEDSAT*, Dennis Wingo, KD4ETA.

Saturday morning was devoted to an intensive discussion forum that provided participants with the following latest developments on Phase 3D:

- *Overall Project Status*, Dr. Karl Meinzer, DJ4ZC
- *Structural and Thermal Design*, Dick Jansson, WD4FAB
- *Antennas*, Stan Wood, WA4NFY
- *Propulsion*, Dick Daniels, W4PUJ
- *IHU, GPS, & RUDAK Computers*, Lyle Johnson, WA7GXD
- *Computers*, Peter Guelzow, DB2OS
- *GPS Experiment*, Tom Clark, W3IWI
- *GPS Computer*, Bdale Garbee, N3EUA
- *SCOPE Digital Color Imaging Experiment*, Hiroyuki Ohata, JM3MAJ
- *Integration Laboratory Management*, Lou McFadin, W5DID

On Sunday morning, participants toured the Spacecraft Integration Facility where Phase 3D is being assembled. Members took the opportunity to meet and ask questions of the international team that is presently assembling Phase 3D.

Saturday evening's banquet was an enjoyable success with Dr. Paul Shuch, N6TX providing an entertaining and mindboggling talk on the search for life among the stars. Dr. Shuch, who is a Professor of Electronics, Pennsylvania College of Technology and Executive Director of the Search for Extra Terrestrial Intelligence (SETI) League, challenged innovators in the Amateur Radio community to establish a real-time all-sky coverage in attempts to be the first humans to receive signals from an alien civilization. (Refer to August 1995 issue of *QST* for additional details.) Another highlight of the banquet came when Bill Burden, WB1BRE, presented Bill Tynan, W3XO with a check for $305,000 from the ARRL AMSAT Phase 3D satellite fund drive. During the banquet, Dick Jansson, WD4FAB was presented the ARRL Technical Merit Award for amateur spacecraft mechanical and thermal design. Also during the banquet, awards were given to members for their volunteer efforts during 1995 (listed on page 23).

The evening cumulated with a multi-prize drawing. Also, Leanore Guimont, KA6UCD presented David Liberman, XE1TU with a bracelet from the third annual electronic jewelry contest. David not only correctly identified that the bracelet was constructed from material used to build a Phase 3D heat pipe, but was closest to estimating the weight of the bracelet.

Many thanks to the following individuals and corporations for donating prizes:

Advanced Electronics Applications
Advanced Receiver Research
American Radio Relay League
Bob Myers Communication
Barker Williamson
Buckmaster
CQ Communications
Dallas Remote Imaging Group
Henry Radio
Joe Holman, KA7LDN
Joe Kasser, G3ZCZ
Larsen
L.L. Grace Communication Products
ICOM Corporation
Craig Mellinger, N2MNA
James Miller, G3RUH
M^2
PacComm Packet Radio Systems, Inc.
SETI League
SSB Electronic USA
Tucson Amateur Packet Radio, Corporation
Ten-Tec
World Radio
Howard Ziserman, WA3GOV

Dr. Paul Shuch, N6TX challenged members at the banquet to get involved in the SETI League. (KC5JVB photo)

Eyeball QSOs were a favorite part of the Symposium. (KC5JVB photo)

The annual meeting allowed particpants to discuss many items directly with AMSAT Board of Directors and Officers. (KC5JVB photo)

The following papers appear in the 182 page conference proceedings:

- *Keplerian Element Estimation for Radio Sputnik 15 (RS-15)*, Ken Ernandes, N2WWD
- *AMSAT-NA Operations Report '95*, Keith Pugh, W5IU
- *The World Wide Web Amateur Satellite Ground Station*, Steven R. Bible, N7HPR
- *The Phase 3D Integrated Housekeeping Unit*, Lyle Johnson, WA7GXD
- *RUDAK-U*, Lyle Johnson, WA7GXD for the RUDAK Team
- *DSP-93 Update: The TAPR/AMSAT Joint DSP Project*, Greg Jones, WD5IVD, Bob Stricklin, N5BRG, and Robert Diersing, N5AHD
- *Instruction to Programming the TAPR/AMSAT DSP-93*, Ron Parsons, W5RKN, Don Haselwood, K4JPJ, and Bob Stricklin, N5BRG
- *Phase 3D Mechanical and Thermal Design*, Dick Jansson, WD4FAB
- *Phase 3D Propulsion Systems*, Dick Daniels, W4PUJ
- *Whither the HAMSATs?*, Keith Baker, KB1SF
- *Extending the Lifetime of Scientific Satellites Using AMSAT Techniques*, Philip Chien, KC4YER
- *Phase 3D GPS Receiver Progress Report*, Bdale Garbee, N3EUA
- *Participate in Picosats!*, Peter Vekinis, ON9CGV/KC1QF
- *AMSAT Net Via Commercial Satellite*, Bruce Paige, KK5DO
- *Developing and Using Satellite Gateway Nodes: A Sysop's Perspective*, Barry Baines, WD3ASW
- *APRtrack, A Program for Determining the Locations of Ground Stations and Spacecraft*, Bob Bruninga, WB4APR
- *MicroSat Ground Station Software for Linux and X-Windows*, John Melton, G0ORX/N6LYT
- *Iowa Satellite Project's Spacecraft Systems and Operations Laboratory's Involvement with BREM-SAT*, Mark A. McKeown
- *Shuttle Amateur Radio Experiment Status 1995*, Frank H. Bauer, KA3HDO and Matt Bordelon, KC5BTL
- *Benbrook Elementary's Experience with the Shuttle Amateur Radio Experiment*, Donna McKinney, N5WOE

Now's the time to make plans for the AMSAT-NA 14th Space Symposium and Annual Meeting which is scheduled to be held in Tucson, Arizona on October 11-13, 1996!

The *1995 Proceedings of the AMSAT-NA 13th Space Symposium* are now available from AMSAT-NA Headquarters. The cost is $12 is US; $15 in Canada; $19 in Europe and $22 in Asia, Africa, and Pacific. Please note that payment must be made in US dollars.

1995 AMSAT Awards

AMSAT Nets

- BRUCE PAIGE, KK5DO: Houston Area Net
- JIM McKIM, W0CY: Mid-continent 75-m net
- WRAY DUDLEY, W8GQW: HF Net Control Station
- RON LONG, W8GUS: East Coast 75-m net
- JOHN SHEW, N4QQ: 17-m net
- JIM SHEPHERD, K6OYY: West Coast 75-m net
- JACK BUTLER, KB7UZ: 15 and 20-m nets
- KEITH PUGH, W5IU: Area Coordinator & Mid-continent 75-m net
- ROGER LEY, WA9PZL: ARK-LA-TEX net

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- GEORGE E. CASWELL, JR. K1MON: New England coordinator
- GERD SCHRICK, WB8IFM: Southwest Ohio cooridinator
- BARRY BAINES, WD4ASW: Jacksonville, FL coordinator and Field Operations
- STEVE GRANT, N8AJD: Southeast Ohio coordinator & membership questionnaire
- BILL RAUSCH, AA6PA: California coordinator
- HOWARD ZISERMAN, WA3GOV: Virginia and Maryland coordinator
- DEE INTERDONATO, NB2F: New Jersey cooridinator
- BILL ROTH, N7RYW: Oregon cooridinator
- TOM SHINGARA, KA3TKW: Pennsylvania coordinator

Communication and Information

- JOHN HANSEN, WA0PTV: AMSAT Journal
- BILL HOOK, W3QBC: Headquarters support
- MIKE CRISLER, N4IFD: 1995 AMSAT Annual Meeting and Space Symposium.
- GLENN MOODY, N4OUL: New member support
- MATY WEINBERG: AMSAT Space Symposium Proceedings
- ROY WELCH, W0SL: AMSAT software technical support
- PAUL WILLIAMSON, KB5MU: Amsat.org & World Wide Web
- MEL ROMAN, KF2WN: AMSAT Sats and Stats BBS
- RUSS TILLMAN, KC5JVB: AMSAT Journal
- HANK FITZ, WB4URU: 1995 AMSAT Annual Meeting and Space Symposium
- KEN QUINN, N4SMY: 1995 AMSAT Annual Meeting and Space Symposium
- BOB WALKER, N4CU: 1995 AMSAT Annual Meeting and Space Symposium.
- JOHN EMRICH, N2REC: AMSAT Support
- STEVE BIBLE, N7HPR: World Wide Web Amateur Satellite Ground Station & PANSAT
- WALT RADER, WA3DMF: QSL manager
- DAVE COWDIN, WD0HHU: ANS bulletins
- RAY HOAD, WA5QGD: orbital elements

Dayton Hamvention Booth

- JAY SATTLER, N8JTR
- TERRY DOUDS, WB8CKI
- DIETER SCHLIEMANN, KX4Y
- RUSTY BAUM, WB0QJB
- JERRY MALIN, WB2LEI

DSP-93

- FRANK PERKINS, WB5IPM: Writing satellite modem software
- RON PARSONS, W5RKN: Beta testing & documentation
- MARK HAMMOND, KC4EBR: Beta testing & software distribution
- TOM McDERMOTT, N5EG: Beta testing & writing Windows application software
- ROBERT DIERSING, N5AHD: DSP-93 Co-Project Manager

AMSAT Field Day Competition Winner

- SCOTTSDALE AMATEUR RADIO CLUB & THE CENTRAL ARIZONA DX ASSN

Phase 3D

- AMERICAN RADIO RELAY LEAGUE
- CENTRAL STATES VHF SOCIETY
- DAYTON AMATEUR RADIO ASSN
- INTERNATIONAL PHASE 3D PROJECT PARTICIPANTS - EUROPE & AFRICA
- INTERNATIONAL PHASE 3D PROJECT PARTICIPANTS - JAPAN
- TAPR
- STAN WOOD, WA4NFY: Antenna investigator
- HANK SILL, AC4ZI: Machinist
- LOU McFADIN, W5DID: Magnetic torque rods & Integration Laboratory Manager
- LYLE JOHNSON, WA7GXD: IHU, RUDAK & GPS processor
- CHUCK HENNESSEY, W4AT: Lab assistance
- PHIL CHIEN, KC4YER: Media coordination
- MIKE PEACOCK, AD4OR: Lab assistance
- GARY HAUGE, N4CHV: Equipment procurement
- KARL MEINZER, DJ4ZC: Phase 3D leadership
- JUNIOR DE CASTRO, PY2BJO: Testing coordination
- BDALE GARBEE, N3EUA: Computer support
- DOUG VARNEY, WA1UVP: GPS experiment
- MIKE SCHWAAB: GPS experiment
- ANGIE REAM, KE4RXJ: Lab assistance
- ROGER REAM, WB4SWZ: Lab assistance
- JAMES FRENCH, KD4DLA: Lab assistance
- MARK KANAWATI, N4TPY: Clean room aquistion
- ELTON SANDERS, WB5MMB: Clean room aquistion
- STUART DUNAWAY, KE4SCY: Microsoft project
- KAI SIWIAK, KE4PT: Anntenna design & equipment procurement
- BERND LUDEWIG, DH5IAE: Spin balancing machine & lab assistance
- RALF ZIMMERMANN, DL1FDT: Spin balancing machine & lab assistance
- BOB CARPENTER, W3OTC: Phase 3D funding campaign
- CHARLES L. GREEN, N0ADI: Hardware development
- LARRY W. BROWN, NW7N: Hardware development
- CATALINA RADIO CLUB: SIMMS production line effort
- G. DAVID BURNETT, WD8KRV: SIMM memory support

SAREX

- LOU McFADIN, W5DID: Principal Investigator
- JOHNSON SPACE CENTER AMATEUR RADIO CLUB, W5RRR
- IBM AMATEUR RADIO CLUB BOCA RATON, FLORIDA
- VIENNA WIRELESS SOCIETY
- MIAMI COUNTY AMATEUR RADIO CLUB
- ARRL/CONNECTICUT DX ASSN
- COWLEY COUNTY AMATEUR RADIO CLUB
- ORANGE PARK AMATEUR RADIO CLUB
- NASHUA AREA RADIO CLUB
- LAKE COUNTY AMATEUR RADIO CLUB
- DAROME TELECOMMUNICATIONS

UNAMSAT

- DAVID LIBERMAN, XE1TU

AO-13 Command Team

- JAMES MILLER, G3RUH
- PETER GUELZOW, DB2OS
- GRAHAM RATCLIFF, VK5AGR

Software Development

- WAYNE ROTH, WA2N: SATSKED software development
- DAVID HOATSON, KC6WYG: KCTDRV software development
- BERNARD PIDOUS, F6BVP: SATCRCS software development
- KENNETH ERNANDES, N2WWD: VEC2TLE software development and updated shuttle vectors
- JOHN ROBERTS, N0DZI: Software support
- BOB BRUNINGA, WB4APR: APRtrack software

Minutes of the AMSAT-NA Board of Director's Meeting Held October 8-9, 1995 in Orlando, Florida

Transcribed by Bill Hook, W3QBC

The meeting was held at the site of the 1995 Annual AMSAT Meeting and Space Symposium, the Orlando Airport Holiday Inn, Orlando, Florida. Members of the Board of Directors in attendance were Keith Baker KB1SF, Tom Clark W3IWI, Dick Daniels W4PUJ, Andy MacAllister, WA5ZIB, Bob Myers W1XT and Bill Tynan W3XO.

Others participating at various times included Martha Saragovitz Corporate Secretary, Jan King W3GEY, Dick Jansson WD4FAB V.P. Engineering, Frank Bauer KA3HDO V.P. for Manned Space Programs, Eric Rosenberg WD3Q, Dennis Wingo KD4ETA SEDSAT-1 Project Manager, Paul Williamson KB5MU V.P. for Electronic Publications, Greg Jones WD5IVD TAPR President, Karl Meinzer DJ4ZC P3D Project Leader, John Nickel WD5EEV Asst. V.P. for Manned Space Programs, Keith Pugh W5IU V.P for Operations, Bill Burden WB1BRE ARRL New England Division Director, Steve Grant N8AJD Southern Ohio Area Coordinator, Harwood Sheppard AA7MH Vice President for Development, David Liberman XE1TU AMSAT Mexico, Stan Wood WA4NFY P3D Integration Team, Chris Anderson NK8W University of Cincinnati, Marty Davidoff K2UBC, Ian Ashley ZL1AOX, Dan Schultz N8FGV, Lou McFadin W5DID P3D Integration Laboratory Manager and Barry Baines WD4ASW. Ray Soifer W2RS V.P. International and Art Feller KB4ZJ Treasurer attended by telephone on October 9.

The meeting was opened by Bill Tynan at 9:30 a.m. on Sunday October 8. Bob Myers W1XT was welcomed as a new member of the Board. Bill expressed regret that Junior deCastro PY2BJO could not be with us because of his wife's illness. Also absent is our treasurer Art Feller due to illness and Ray Soifer V.P. International. Both of them are to be available Monday morning on a telephone call. Junior had said that he would also be available by phone if we should need him for consultation or a vote.

Satellite Orbital Elements

by Ray Hoad, WA5QGD

Satellite	AO-10	UO-11	RS-10/11	AO-13	FO-20	RS-12/13	RS-15
Catalog	14129	14781	18129	19216	20480	21089	23439
Epoch Time	95301.7973408	95312.0076286	95312.0458837	95312.9696279	95312.1785206	95313.1847293	95312.6298096
Element Set	383	842	135	108	833	843	90
Inclination	026.4483	097.7871	082.9245	57.4296	99.0641	82.9230	64.8177
RA of Node	241.3041	307.8396	312.7342	154.0272	13.9479	353.2460	21.3820
Eccentricity	0.5979377	0.0012997	0.0013329	0.7346381	0.0539795	0.0030062	0.0166782
Arg of Perigee	321.7524	081.2952	054.0088	23.2353	267.4453	125.8627	237.5072
Mean Anomaly	008.2043	278.9721	306.2297	357.6953	86.4773	234.5324	120.9633
Mean Motion	02.05879727	14.69396068	13.72358626	2.09725300	12.83231287	13.74061957	11.27524533
Decay Rate	-.00000147	.00000185	.00000040	.00000049	-.00000057	.00000038	-.00000039
Epoch Rev	9305	62502	41970	5669	26941	23868	3580
Satellite	UO-14	AO-16	DO-17	WO-18	LO-19	UO-22	KO-23
Catalog	20437	20439	20440	20441	20442	21575	22077
Epoch Time	95313.2110432	95312.1976939	95312.1019930	95312.2271138	95312.1695490	95312.1426522	95312.0409336
Element Set	138	944	946	941	952	654	536
Inclination	98.5617	098.5733	098.5752	98.5747	098.5763	098.3818	066.0826
RA of Node	35.2020	036.0735	036.5063	36.5887	036.9417	019.8003	294.5777
Eccentricity	0.0011274	0.0011380	0.0011577	0.0011957	0.0012359	0.0006627	0.0001385
Arg of Perigee	127.7188	131.3227	130.8060	131.1486	130.5984	208.4798	010.3582
Mean Anomaly	232.5021	228.8935	229.4116	229.0722	229.6271	151.6030	349.7458
Mean Motion	14.29902293	14.29956970	14.30098549	14.30068876	14.30173974	14.36998297	12.86293162
Decay Rate	.00000008	.00000017	.00000004	-.00000010	.00000034	.00000029	-.00000037
Epoch Rev	30247	30234	30235	30237	30238	22617	15223
Satellite	AO-27	IO-26	KO-25	MET-2/21	NOAA-14	MIR	HUBBLE
Catalog	22825	22826	22828	22782	23455	16609	20580
Epoch Time	95312.1228843	95312.1360033	95312.0991652	95312.1041451	95312.8477908	95312.1296990	95312.0869708
Element Set	435	439	418	453	387	356	740
Inclination	098.6069	098.6069	098.6031	082.5488	98.9184	051.6456	028.4702
RA of Node	026.4292	026.5631	026.5725	163.1464	254.3188	156.7659	206.1140
Eccentricity	0.0008136	0.0008812	0.0009879	0.0020830	0.0010041	0.0003515	0.0006193
Arg of Perigee	155.2622	156.3426	141.6657	239.3112	140.3015	295.4180	009.3080
Mean Anomaly	204.8926	203.8162	218.5218	120.5996	219.8892	064.6451	350.7619
Mean Motion	14.27677562	14.27785634	14.28118492	13.83042029	14.11545188	15.57967528	14.90967221
Decay Rate	-.00000001	.00000011	.00000026	.00000031	.00000001	.00004462	.00000504
Epoch Rev	11030	11031	7841	11043	4422	55539	10540

I. Election of Officers

Bill Tynan asked if there were any volunteer for the office of President. A deathly silence followed. Tom Clark then moved that the incumbent officers be reelected by acclamation. Dick Daniels seconded and the motion passed unanimously.

II. Auditor's Report

Martha presented the audited financial statement for 1994 prepared by the accounting firm of Verkouteren, Auerbach, Olson and Co. with the statement that Art Feller had urged its approval. Tom Clark moved that the statement be accepted and that this firm be retained to provide us with an audited report and assistance in tax and related matters during 1996. The motion was seconded by Keith Baker and accepted by unanimous vote.

III. DSP-93 Project

Greg Jones presented the status of the project. He said that there are approximately 150 kits out and that he expects the next run to be 100. He also said that the intention is to continue to accept orders in groups and then purchase parts to cover them. For this reason, he does not expect to require any further money from AMSAT. He indicated, however, that he does not expect much in the way of revenue. On the suggestion of Tom Clark, the Board members present expressed a consensus that AMSAT appreciates the work of TAPR and its volunteers in creating DSP-93 and its software. Dick Jansson also expressed appreciation for the work TAPR volunteers have done in the Phase 3D project as well as the $6,000 financial contribution made.

IV. SAREX

Frank Bauer noted the changes that have taken place in the SAREX organization over the past year. Of particular note was the retirement from NASA JSC of Lou McFadin who is now Manager of the Phase 3D Integration Laboratory. The new SAREX Principal Investigator (PI) is Matt Bordelon KC5BTL.

Frank went on to report on a meeting held in Houston in August, one of the major topics of which was to define Amateur Radio's role on the Space Station. He said that if we had been an official participant a year or more ago, there is a good possibility that we might have been removed in all of the changes that have taken place in the Program - including the considerable downsizing. He said, however that the August meeting went a long way toward setting the stage for Amateur Radio to be included on the Station. He said that the Laboratory Module is already pretty much defined and full, so that our equipment would probably be included in the Habitation Module, which is now just being defined. Bill Tynan expressed the opinion that that is probably where we would want to be anyway. Dick Daniels said that it would be preferable for us to be "part of the Space Station", rather than an "experiment" in competition with other experiments. He cited experiences in the SAREX Program in support of this contention. Frank agreed, saying that the problem with being "an experiment" is it that it would be easier for us to be bumped later. Furthermore he said that the way Amateur Radio's participation is being considered is as a "psychological enhancement - recreational" activity. He cited the recent experience of Norm Thagard on MIR and said that was probably the best thing that could have happened for us. Following the August meeting, Frank said, our task now is to define our requirements - before trying to pin down any actual equipment needs. That work is in the "requirements definition phase". Various things are being considered such as television digital data compression, spread spectrum etc. Tom mentioned the possibility of having the Space Station tied into the Internet via a world wide system of Amateur Radio ground stations. Dennis Wingo said that his group is already in the process of writing software that might support this. Frank said that what they are doing is developing the "core" equipment suite and then the question as to how it might be used can follow.

Eric Rosenberg brought up some of the negative feelings that have been expressed to him by people of other nations regarding SAREX and MIR operations. Frank said that one of the things the SAREX group is trying to do is find ways to involve other countries for the pooling of resources. They are drafting a letter to try to identify points of contact in the various countries participating in Space Station. It was noted that there is a licensing issue. Bill Tynan asked if it could be licensed by the U.N. He suggested that it would give it the proper international flavor. He also suggested that some kind of international council might be set up to handle such problems and suggested that Frank work with Ray Soifer on this.

Another major effort that Frank reported is the drafting of SAREX "guidelines". This document has been in the works over the past three years and was one of the items taken up at the August meeting in Houston. Its purpose is to serve as the basic agreement between the SAREX Working Group, the Astronaut Office and the Space Shuttle Program Office. It has now been provided to all of the Shuttle astronauts to inform them of what SAREX is and how it should be used. Frank said these guidelines are published in the Space Symposium Proceedings. *[Editor's note: These guidelines will be published in a forthcoming issue of The AMSAT Journal.]*

Frank then outlined the three SAREX missions flown so far in 1995 and the one remaining mission, STS-74 scheduled for November. It will be the second MIR docking mission. Those already flown were the lengthy STS-67 mission, STS-70, and the MIR docking mission STS-71. He noted that, due to the busy nature of that mission, SAREX participation on it was not as evident as on other missions. It accommodated only a few amateur QSOs and only five school schedules. Frank stated that this will probably be true of future MIR docking missions, which will become more numerous. One of the subjects discussed at the August meeting in Houston was SAREX involvement on MIR docking missions and how we can make the most out of them. They are only nine day missions and there is little chance to use the SAREX equipment until after undocking. One of the approaches being explored is more use the MIR equipment to conduct school schedules and other Amateur Radio related activities. He said that this is one of the major efforts underway, and that it is part of the overall situation dictating that SAREX operations must change. He noted the operations changes required when SAREX transitioned from handling one mission every few years to four missions per year, each with multiple school schedules. Each such mission requires the active participation of a number of volunteers. SAREX expects to change its operations again when it transitions to a permanent presence in space on MIR and the International Space Station. If the team does not transition, such increased activity has the potential to lead to "burn-out". Frank said that he would like to transition to a more continuous process, where there is a school schedule once per week rather then a group of them in the space of a few days. Such a situation should prevail on Space Station and is presumably possible using the MIR equipment. But key to that is obtaining Third Party agreements with Russia and other countries for the educational programs on a permanent basis. Permission was obtained late in the STS-71 Mission to allow Charlie Precourt KB5YSQ to talk to a Massachusetts school. It is hoped that this might serve as a precedent for a permanent agreement. Frank said that work is continuing with the State Department and NASA's Office of International Affairs.

Tom brought up the question of frequencies and equipment. The use of 2 meters, for both up and down links seems always to present problems. He wondered if 70 cm could be used? It was noted that there is now 70 cm equipment on MIR. Bill Tynan noted the Doppler inherent in the use of 70 cm with such a low orbit. Several noted that they had worked the Shuttle on 70 cm several years ago during the German operation on Spacelab. Several more astronauts and cosmonauts are in training to obtain ham licenses.

Frank stated that there are five flights in 1996 including two of long duration and three that involve MIR (See Table 1).

Dennis Wingo said that he want to work with Frank to get SAREX on STS-85 in July 1997 which is to be the mission deploying the tether with SEDSAT. He said that the astronauts on that mission have expressed an interest in having Amateur Radio included. He described the possibility of a real-time contact between hams on STS-85 and the SEDSAT spacecraft. Steve Bible said that PANSAT is to be launched on STS-86 in September 1997.

Frank noted that the Santa Rosa, California Junior College has received $30K in donations to set up a station for shuttle and other space-related amateur contacts. He and Rosalie White of ARRL headquarters presented three seminars at the school on how elementary, high school and college students might become involved.

Tom Clark proposed that a small workshop on new equipment ideas for SAREX and the Space Station be convened. Dennis Wingo said that this could be done in connection with the microsatellite conference being planned at the University of Alabama at Huntsville next spring. In addition to radio amateurs, participants will include representatives from universities active in space education and research.

Frank reported that 25 slide sets are being prepared as an "introductory" presentation on SAREX. These can be used by Amateur Radio and school groups to acquaint people with the project and describe it and how hams participate. A large number of cloth SAREX patches have been obtained that display the NASA, ARRL and AMSAT logos. *[Editors Note: See page 19.]* These will be made available by AMSAT. It is hoped that these will serve to raise revenue. Bill Tynan urged the completion of the operating manual for SAREX participants and noted that such a publication would be a good way to raise funds to help balance SAREX expenses. Frank promised to check the status of this.

A discussion followed of AMSAT's budget items designated in support of the SAREX program. Frank said that it seems generally acceptable as presented, however he envisioned the possible need for some international travel in connection with Space Station. It was agreed that the current budget does not address this kind of expenditure and that adjustments would have to be made if such a need should arise.

The subject of SAREX frequencies was held the following day during the phone hook-up with Ray Soifer and Art Feller per the agenda.

V. AMSAT Internet Facility and Electronic Publishing

Bill Tynan mentioned the increasing number of irrelevant commercial and other non-amateur messages that have appeared on the amsat.org e-mail facility. He asked if there is a way to filter out such items without eliminating anyone who is truly interested in satellites. Paul Williamson replied that it was technically possible using artificial intelligence to limit access. However, for the AMSAT BBS that would be difficult and likely to introduce significant delays. The conclusion was that the practical thing to do now is to put up with the "noise" and look forward to future automatic scanning and referral to the sysop.

Paul described how the BBS has been upgraded by moving to a dedicated computer for the Web and FTP sites. Noting that although $5K had been allocated for upgrading, less than $1.5K was spent to provide a faster server and greatly increased disk space.

Bill Tynan introduced an agenda item dealing with placing our Audited Financial Report on our Web page. Martha noted that our accountants, citing certain precedents, did not favor such an action. Although several officers and BoD members agreed with the accountants, it was Paul's opinion that in the spirit of openness, the audit should be made available electronically. Dick Daniels moved that we continue to distribute the audit in paper form to anyone requesting it as has been done in the past. The motion was seconded by Keith Baker and passed. Tom Clark recommended that the availability of the audit be announced on the Web page and that henceforth, AMSAT should provide the envelope and postage for the mailing. There were no objections.

The question of using the WWW ground station operating at the Naval Postgraduate School as a gateway to the amateur digital satellites was discussed. So far, there has not been any request from the school for any kind of AMSAT involvement. In view of this and possible legal issues involved, Tom Clark was asked by the president to assemble a group of experts to make recommendations to be ready in case we are asked to participate in some way.

The question of the distribution as shareware of tracking and certain other software on the Internet was next considered insofar as it may compete with the software distributed in our fund-raising efforts. It was noted that the computer programs donated to AMSAT remain the intellectual property of the authors. After much discussion it was agreed that there was no easy solution and that no actions should be taken to limit the availability of such software.

VI. 1997 Annual Meeting

A presentation was made by Robin Haighton, VE3FRH suggesting that the 1997 AMSAT Annual Meeting and Space Symposium be held in Toronto, Ontario Canada. Tom Clark moved that AMSAT tentatively accept the offer of the Toronto group and encouraged them to provide us with details. The motion was seconded by Keith Baker and passed unanimously.

VII. University Involvement in Small Satellite Projects

Dennis Wingo noted that there now seems to be a "critical mass" of small satellite projects at universities around this country and overseas. He cited several. Contributing to this interest has been a NASA program to provide funds for university small satellite projects through the University Space Research Association (USRA). He noted that the Small Satellite Conference has turned from an AMSAT/military/educational meeting into one devoted to commercial applications of small satellites. Dennis then presented plans for a small satellite conference with a particular emphasis on university and non-profit group involvement. He said that the conference, which would be in the nature of a forum, will be held this coming spring in Huntsville. He indicated that Space Grant Consortium funds may be available to bring students from various universities to the forum. He specifically asked for AMSAT to be a co-sponsor of this conference, saying that he has a concern that many of these groups are unaware of AMSAT, its activities and expertise in this arena, or in the nature of Amateur Radio and how it might and might not be used. He further stated that many such non-amateur groups have little knowledge of the licensing, frequency allocation and ground control station requirements. After discussion, Tom Clark proposed a resolution stating that AMSAT will support and co-sponsor the Huntsville conference. It was seconded by Bob Myers and passed unanimously.

Dennis's presentation led to a general discussion on AMSAT's possible role in cooperation with university satellite projects. A thought expressed by Tom Clark was that AMSAT might become source of space hardware for these projects. He noted that the University of Colorado had spent $300,000 to $400,000 on RF hardware. Bill Tynan noted that Stanford had bought off-the-shelf hardware for their SAPPHIRE satellite. He noted that this might be a possible source of revenue as well as providing some degree of control over what gets launched.

This raised the general subject of universities building amateur satellites for the prime purpose of conducting various scientific experiments, some of which may not be associated with subjects related to radio. Bill Tynan noted that this calls into question the entire subject of amateur satellites and what they should be allowed to do. He expressed the opinion that whatever rules are presently used may severely restrict types of data that amateur satellites should be allowed to transmit, should be liberalized to permit transmission of scientific data in general, not just that relating to radio. He said that he did not know precisely what form this should take but cited the suggestion that had been made several times by Jan King that specific frequencies within the amateur bands, preferably in the microwave bands, be established for such purposes.

AMSAT's future role with universities came in for extended discussion. Dick Daniels expressed concern that, by acting to encourage university involvement, we might promote unwanted use of the amateur bands. Tom Clark shared the view that universities are already interested in putting satellites on Amateur Radio bands and that our involvement should provide a means of guiding that activity in the right direction. In other words its happening with or without our participation.

There was no action on this but it was recognized that it is a controversial question and requires considerable further study.

VIII. Making MICROSAT Design Data More Freely Available to Non-commercial Groups

Bill Tynan introduced an agenda topic that had been requested by Bob Twiggs KE6QMD of Stanford University. This involves making AMSAT's Microsat designs available to amateur, non-commercial, or non-government groups free of charge. This would replace the previous policy in which payment was asked, to defray AMSAT's cost in the MICROSAT Project. Prof. Twiggs specifically proposed to put the information in electronic form and have it available for downloading once a specific group had been determined to meet the non-commercial and non-government criterion. He offered to be the keeper of the information. The need to include the Microsat operating system software was also noted.

The general consensus was that the time has come when such action should be taken. It was noted that the MICROSAT technology is now mature and AMSAT has pretty much recovered its investment. It was also

Table 1 - 1996 SAREX Flights

Mission	Date/Duration	Amateur Radio Crew	Inclination	Mode
STS-76 Mir Docking Fit 3 Atlantis	March/9 days	Richard Searfoss, KC5CKM Shannon Lucid, TDB Linda Godwin, N5RAX Ron Sega, KC5ETH	51.6	FM Voice
STS-78 LMS Columbia	June/16 days	Susan Helms, TDB Charles Brady, N4BQW Robert Thirsk, VA3CSA Jean-Jacques Favier, TDB	39	FM Voice FM Packet
STS-79 Mir Docking Fit-4 Atlantis	August/9 days	Jay Apt, N5QWL Jerry Linenger, KC5HBR	51.6	FM Voice
STS-80 Columbia	November/16 days	To be announced	28.5	FM Voice FM Packet
STS-81 Mir Docking Fit-5 Atlantis	December/9 days	To be announced	51.6	FM Voice

noted that the task of servicing those organizations which have received the technology under the existing policy places a significant strain on many AMSAT volunteers who are quite busy with other things. The inference was expressed that no-cost distribution would carry less pressure to respond to requests for further and more detailed information.

Tom Clark offered the opinion that making MICROSAT technology more available should contribute to getting younger amateurs and university groups involved and is the best way to ensure the survival of the Amateur Satellite Service.

Accordingly Dick Daniels moved that AMSAT release the MICROSAT design and technology to Amateur Radio or educational organizations at a no cost, but controlled, basis. This is not to infer that AMSAT will necessarily provide further support to those using the technology. Tom Clark suggested adding the stipulations that any group acquiring and using the MICROSAT technology must agree to make available any improvements and/or modifications to the design available to the amateur community. The motion was seconded by Bob Myers and passed unanimously. An announcement will soon be made of this new policy.

Other university-sponsored small satellite projects were discussed. Tom Clark and David Liberman presented details of UNAMSAT-B. Frank Bauer presented some information on SPARTAN built at the University of Maryland and due to fly on a Shuttle mission. Its lifetime is apparently limited to a few days. Lyle Johnson gave some information on the latest status of ASU-SAT from Arizona State University. The SAPPHIRE satellite was described by Bill Tynan who had visited Bob Twiggs at Stanford a few weeks before. He said that it is basically a combination of DOVE and WO-18. It will carry a camera and a voice synthesizer and operate in the Amateur bands. He noted that Twiggs and several students had taken the actual flight hardware to the Small Satellite conference several weeks ago and took pictures of NASA Administrator Dan Golden using the satellite.

IX. Future Plans Following Phase 3D

Keith Baker introduced this topic, noting that it had been authorized by Board action last year. As a part of this effort, a six question survey had been made to about 800 AMSAT members. The survey was put together by Steve Grant N8AJD with help from Martha and Bob Carpenter W3OTC. Steve gave a preliminary report of the results based on returns from 224 so far. This report indicated that most of the respondents hold either the Extra or Advanced class license. While the majority reported that they had not been active on the satellites in the past 90 days, the criterion selected for defining activity, AO-13 was the most popular choice among those who had been active. With regard to the type of satellites that the respondents would like to see constructed in the future, the majority chose the analog/SSB mode in a P3D-type or geosynchronous orbit. But, there was also a significant number seeking low altitude packet and FM birds. Final results will be released at a later date and published in *The AMSAT Journal*.

Chris Anderson who is associated with the Space Engineering Research Center at the University of Cincinnati described a sounding rocket assembled by students at his institution. He said that it is to be launched from Wallops Island, Virginia next spring. He said that they are now looking for follow-up projects and observed that there may be several Delta piggyback launch opportunities possible in 1997. The concept that his group is considering involves the construction of a small, light weight geosynchronous satellite for use by amateurs employing graphite composite materials for launch in 1997. He postulated that it might use the 5.7 and 10.5 GHz bands for a 30 MHz wide 200 Watt transponder and employ a reflector/sub-reflector antenna assembly with solar cells mounted on the back of the dish. Spot beams would be used to achieve the high gain needed to provide the necessary EIRP and afford coverage of Continental U.S.

A number of questions were raised relative to schedule, power budget, attitude control and rocket energy needed to get the proposed spacecraft to geosynchronous orbit. Anderson said that there are a number of unanswered questions and asked for access to AMSAT's technical expertise in the design and construction of the satellite. It was suggested that a more complete design disclosure be presented at the spring symposium at Huntsville.

Bill Tynan offered the motion that we would like to encourage this effort in every way we can and offer to support it with the resources we have available, considering our commitments to Phase 3D. Tom Clark pointed out that "the resources we have available are volunteer people". Specifically, it was the general feeling that AMSAT would try to send representatives to Critical Design Review meetings. The motion was seconded by Keith Baker. The motion passed unanimously. Chris was asked to keep us informed as to progress and that individual AMSAT members would be glad to consult on the project, time permitting.

Bill Tynan noted that, although he was given a place on the agenda, Peter Vekinis was not present to outline his concept for PICOSATs. He had presented a paper at the symposium on the subject. Since he was not present, there was no further discussion and the Board took no action on the concept.

Greg Jones reported on an impending request for rule making to be submitted to FCC requesting revision of the present spread spectrum rules. He suggested that AMSAT may wish to evaluate this and make appropriate comments to the FCC when the time comes. It was agreed that this is the proper course of action in this matter.

X. Phase 3D Progress Report

Dick Jansson summarized recent accomplishments and the work in progress. The spaceframe is ready for wiring and the propulsion system plumbing is almost completed. However all of it must be removed and sent out for pass. A fit-check has been made of the SCOPE camera module and the proper holes cut in the top plate to accommodate the lenses. The IHU is complete and in Marburg for Karl's evaluation. A need had been identified for a "mux/demux" function. These were combined into one unit, called an I/O module which was designed and constructed by Lyle Johnson and Chuck Green.

All of the flight receivers have either been checked out or are about to be. Final acceptance testing on receivers will be done in Marburg by Karl. Receivers for 21 MHz, 24 MHz, 146 MHz, 1269 MHz, 2401 MHz, 2446 MHz and 5.6 GHz plus an HF spectrum analyzer are to be included. Bill Tynan questioned inclusion of a 24 MHz receiver as that band in not an ITU Amateur Satellite Service allocation.

The South African 10 meter transmitter is to be ready early in 1996. The 2 meter (V Band) transmitter was received by Karl and found to have some capacitors operating at higher than desired temperatures. It was returned to the builder for rework. It was noted that it does not have as high an efficiency as desired, and will thus probably have to be operated at lower power than originally expected. The 70 cm (U Band) transmitter is nearly ready. There are two S Band transmitter projects, one in Belgium and one by a group from the Munich area of Germany. At this time, it is not certain which will fly. There are also two X band transmitters, both from Finland. One is a 16 watt GaAsFET type and the other uses a 50 Watt TWTA. The latter will require more physical space than is presently allocated. A 1 Watt K band transmitter is essentially complete. It was reported that a TWTA for that may also be available.

Relays to switch between the 2 meter and 70 cm antenna arrays and their respective transmitters and receivers have been ordered. These relays are quite expensive because of the extensive testing required to confirm that they are not subject to multipacting breakdown.

Lou McFadin reported that the wiring plan is finished and the RF "road-map" is now available. All 10.7 MHz cables are in place on the spaceframe, as are the wiring and terminal strips for the power distribution. Lou has a plan for the power switching unit for which Chuck Green has agreed to help with the circuit board. Dick said that one area of concern is the Sensor Electronic Unit (SEU). Karl will be checking on its status as soon as he returns home.

The arcjet motor has been delivered and Dieter Zube will come to Orlando to install it. Dick Jansson reported that the second SBS is nearly complete and that he will accept it when he visits Utah soon for shock tests of the first SBS.

Tom Clark reported that the spacecraft's GPS receiver is nearing completion and a prototype of the associated computer is working well. He said that the attitude determination software is yet to be done but that he has identified a potential writer for it. He also said that a multi-satellite simulator is being installed at Goddard which can be used to confirm operation of the system under conditions expected in orbit. Karl and Tom engaged in a protracted discussion relative to the performance of GPS to determine spacecraft attitude, particularly at apogee. It was agreed that there are significant questions here, including the antenna pattern characteristics of the GPS satellites. There are also questions concerning the RFI environment on the spacecraft.

Karl Meinzer advised that the main battery is in storage, ready for delivery. Cover glasses for the solar cells are presently being manufactured. For the auxiliary battery, 150 10 amp/hr cells have been purchased and will be delivered by February 1. A site for testing and screening these cells to identify those to be flown is being investigated. Dick Jansson noted that the mounts for this battery were fabricated in New Zealand and hand delivered by Ian Ashley and Mark Shepherd. He commented that a beautiful job was done on machining them and that this makes the 13th country that is contributing hardware to Phase 3D.

Stan Wood reported on antenna progress. Karl had suggested that the 2 meter antennas be raised somewhat in order to lower the Q. Currently, the Q is rather high, which could lead to phase shift problems over the band between the three antennas. Stan is looking into this. The 70 cm patches are in good shape.

Stan reported that he is not yet happy with the feed for the short backfire for the 1269 MHz uplink and is still working on it. Some difficulty was experienced in getting proper illumination of the S Band and C Band dishes, until Freddy DeGuchteneire ON6UG paid a visit. Stan said that Freddy's tapered cup design did the trick. For the C Band, commercial cable TV dishes were tried, but found not to be parabolas. Freddy will build the C Band dishes which will be used on the spacecraft. The antennas for the higher bands are to supplied by the transmitter makers.

The P3D team has scheduled the following plan for activities:

- Completion of wiring harness: 1 February
- Begin testing of power and digital systems: 1 February
- Bring on other module groups: Various dates following 1 February
- Begin environmental testing: 1 July
- Apply external coatings: Following completion of testing

Some of the anticipated costs associated with environmental testing were outlined. They include; $30K for the construction of a shake fixture and $12K for the liquid nitrogen needed for thermal tests. In addition, the possible cost for accomplishing the vibration testing is being evaluated as are costs for shipping P3D to testing site(s).

Dick Jansson reported that ESA requires that a static load test be made of one of the SBSs next spring. It was this requirement that was one of the factors that contributed to the decision to build the second SBS. We didn't want to send our only SBS to France.

It was noted that an offer was made at last year's Board meeting by Junior deCastro to conduct tests in Brazil. Dick Jansson and Bill Tynan reported that they went to Brazil in February to get further details on this possibility. They found the site adequate for the job and the personnel very knowledgeable and professional. They reported that, despite this, it has been determined that the logistics and costs involved in doing the testing in Brazil made it impractical if another site could be located. A site, or sites (thermal vacuum at one and vibration possibly at the other) have been located in the Maryland suburbs of Washington, DC and it has been decided to go ahead with testing there.

Karl Meinzer reported that the current schedule for Ariane 502, the prime launcher for Phase 3D, is now September 1996. However, he said, that ESA has informed us that we may have to go on an Ariane 4 instead. They have stated that this would be by mid-1997 at the latest. He expressed the belief that the most likely date is December, 1996.

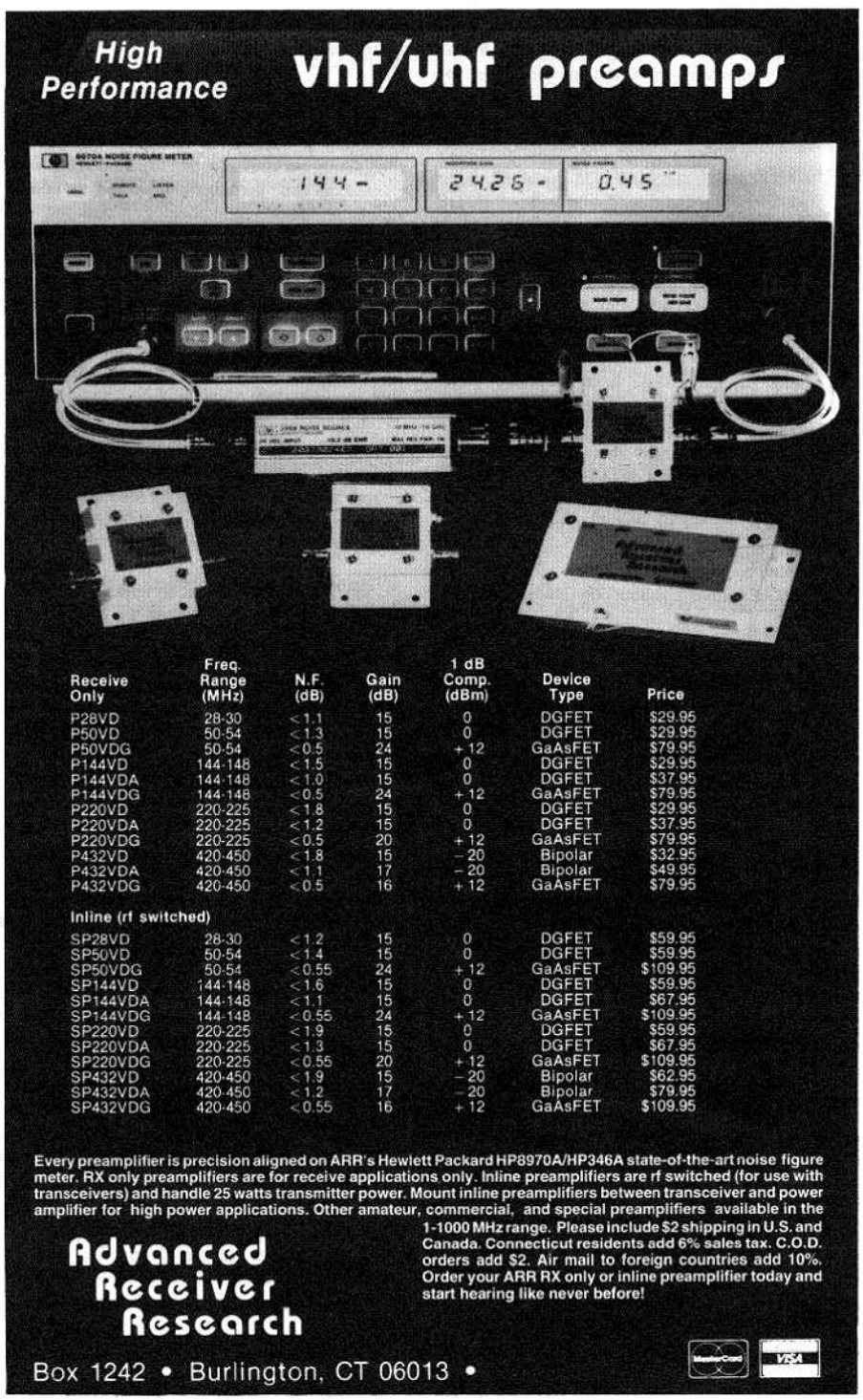
Stan Wood has been investigating the cost for transporting the spacecraft to the launch facility. He reported that Air France has a 747 which goes from Miami to France where the spacecraft can be forwarded to on to Kourou. The cost is apparently in the vicinity of $5K. This is considerably less than had been anticipated.

XI. P3D Funding

Keith Baker presented a picture of the AMSAT-NA expenditures in support of Phase 3D. To date for P3D they are just under $640,000. He had estimated the amount for 1996, exclusive of launch costs, to be about $200,000. But it was concluded that this number had to be looked at again in the light of a stretch-out of the Project and a possible launch sometime toward the end of 1996. It was concluded that a meeting must be convened following the Board meeting to come up with a more realistic number.

Karl said that the first installment of the launch fee, about $800K, is due 1 November and that he needs the $200K which we had promised to help support this. Bill Tynan asked Martha to begin the process of transferring this money. Karl said that the total launch fee will be about $1,000,000. Bill noted that the $200K which we will be sending is from the first ARRL campaign. Karl asked if we can supply more than the $200K? Bill said, as he had said previously in answer to this question, that we will if we can, but that we must evaluate our income and expenses through launch before committing to the additional amount.

Keith went on to report that the amounts raised for the P3D project on this side of the Atlantic thus far include $500K from the ARRL ($200K in the first campaign and about $300k in the most recent) and about $480K contributed directly by AMSAT-NA members. He said that AMSAT-NA has spent approximately $640K. Thus, there is a shortfall of about $160K. This has had to come out of reserves we had prior to beginning the P3D Project. Efforts are being made to obtain additional funds from large corporate and foundation donors. It was stated that there may be an opportunity to extend the ARRL matching fund program through the remainder of 1995. The League Executive Committee had made such a recommendation and sent it to the Board for a



Receive Only	Freq. Range (MHz)	N.F. (dB)	Gain (dB)	1 dB Comp. (dBm)	Device Type	Price
P28VD	28-30	<1.1	15	0	DGFET	$29.95
P50VD	50-54	<1.3	15	0	DGFET	$29.95
P50VDG	50-54	<0.5	24	+12	GaAsFET	$79.95
P144VD	144-148	<1.5	15	0	DGFET	$29.95
P144VDA	144-148	<1.0	15	0	DGFET	$37.95
P144VDG	144-148	<0.5	24	+12	GaAsFET	$79.95
P220VD	220-225	<1.8	15	0	DGFET	$29.95
P220VDA	220-225	<1.2	15	0	DGFET	$37.95
P220VDG	220-225	<0.5	20	+12	GaAsFET	$79.95
P432VD	420-450	<1.8	15	-20	Bipolar	$32.95
P432VDA	420-450	<1.1	17	-20	Bipolar	$49.95
P432VDG	420-450	<0.5	16	+12	GaAsFET	$79.95
Inline (rf switched)						
SP28VD	28-30	<1.2	15	0	DGFET	$59.95
SP50VD	50-54	<1.4	15	0	DGFET	$59.95
SP50VDG	50-54	<0.55	24	+12	GaAsFET	$109.95
SP144VD	144-148	<1.6	15	0	DGFET	$59.95
SP144VDA	144-148	<1.1	15	0	DGFET	$67.95
SP144VDG	144-148	<0.55	24	+12	GaAsFET	$109.95
SP220VD	220-225	<1.9	15	0	DGFET	$59.95
SP220VDA	220-225	<1.3	15	0	DGFET	$67.95
SP220VDG	220-225	<0.55	20	+12	GaAsFET	$109.95
SP432VD	420-450	<1.9	15	-20	Bipolar	$62.95
SP432VDA	420-450	<1.2	17	-20	Bipolar	$79.95
SP432VDG	420-450	<0.55	16	+12	GaAsFET	$109.95

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vote. [It has since been learned that this proposal passed by 15 to 0.]

Martha stated the need to publicize all matching grants. She considered that the overall financial picture will be satisfactory if fund raising efforts continue to be successful. Bill said that, at the time, he was precluded from disclosing that the Hoover Foundation is the organization offering the $50K of matching funding through the end of 1995. He indicated that he hoped to be released from this soon. [Since the meeting, Herbert Hoover III W6ZH has informed Bill that he can say that the Hoover Foundation is the organization supplying the matching funds.]

Karl Meinzer agreed to supply a summary of AMSAT-DL's. income and expenses for P3D. It was noted that AMSAT-DL has been very successful in raising funds. Revised estimates of expenses revealed that to bring P3D to completion including launch, approximately $200K additional must be raised. It was recognized that the AMSAT membership in many cases had already completed their pledges and that additional sources of funding need to be found. Bill Tynan mentioned the major donor program which he introduced at the Annual Meeting. For each individual or organization donating $2,500, a solar cell will be dedicated and the party making the donation will receive a large plaque with an engraving of the satellite and a notation of the specific cell or cells dedicated to them.

V.P. for Development Sheppard reported on his fund-raising effort that is directed toward corporate and foundation sources. He emphasized that it will take a while to produce sizable results. The advisability of having potential donors visit the Orlando P3D facility was discussed. Shep described some of the organizations that he had thus far contacted and asked for additional names.

A protracted discussion ensued concerning the 1996 Phase 3D budget and revenue prospects. It was generally considered that another look at the figures would be necessary before it could be approved.

Bob Myers reminded the Board that we had earlier promised to print the names of P3D donors in *The AMSAT Journal*. In consideration of the approximately 3000 persons that have contributed thus far, the listing will have to occupy more than one issue and should begin soon. It was also suggested that a thermometer-type graph appear occasionally to indicate the percentage of the P3D goal achieved.

XII. Other Matters

Noting the impressive presentation at the dinner meeting by Paul Shuch N6TX, Dick Daniels moved that AMSAT-NA join the SETI League as a Charter Member, and that we welcome the opportunity to work with the SETI League in technical areas of mutual interest. Bill Tynan also noted that AMSAT had provided the SETI League's Executive Director, Dr. Shuch, with a forum to promote his organization's objectives and paid some of his expenses. The motion was seconded by Bob Myers and passed without opposition.

XIII Administrative Matters

Bill Tynan brought up the agenda item proposing a change in the existing AMSAT policy of reimbursing volunteers who travel on AMSAT business only for transportation and lodging expenses but not for food expenses. He expressed the opinion that this policy works a hardship and is unfair. It also noted that it is completely at odds with other organizations, both commercial and non-profit. He suggested changing the policy to reimburse travelers for food up to $15 per day, with presentation of proper receipts. He emphasized that this would not be a per-diem, but actual expenses. Dick Daniels stated his opposition to the proposal saying that he thought that the existing policy is appropriate to a "hobby" type organization. He was also concerned as to how the proposed change would go with the members who we are asking to donate to Phase 3D. Bill mentioned the fact that some volunteers must travel a good percentage of the time in order to accomplish their AMSAT work. A thought was expressed that maybe special cases could be made whereby the existing policy could be waved for certain travelers. But, the consensus was that this would not be feasible.

Accordingl y, Tom Clark moved to modify the present travel policy to allow reimbursement for food of up to $15/day for authorized travelers provided proper documentation is provided. But, this amount could be higher for travel to high cost areas if approved by the President or Executive Vice President. The motion was seconded by Keith Baker and passed with Dick Daniels voting as opposed.

XIII. AMSAT Securities and Investments

Ray Soifer and Treasurer Art Feller joined in this discussion by long distance telephone. Art announced that in view of his retirement from the FCC, his possible conflict of interest situation involving AMSAT investments in communications stocks is no longer an issue. Noting the increase in spending for P3D, he asked for the schedules for launch and other payments so that an appropriate strategy may be developed for handling the invested funds. It was concluded that the budget as presented did not properly reflect the 1996 costs associated with Phase 3D, especially in view of a probable launch during that year. Accordingly, it was decided that a meeting would be held after the Board meeting to appropriately adjust these figures. BoD approval of the revised budget will be sought by e-mail vote.

XIV. IARU and other International Matters

Ray Soifer reported on a recent meeting with Hans van de Groenendaal ZS5AKV who had just attended the IARU Region 2 meeting and the IARU Administrative Council (AC) meeting in Niagara Falls, Ontario. Hans reported that the AC had made a slight change in the Terms of Reference for the position of IARU AMSAT Frequency Coordinator (IAFC). The main thrust of this change removed the AC from the loop of appointing a person to this position and left the matter to the IARU Amateur Satellite Advisor (Hans) and the various AMSAT groups. Hans also reported that five candidates had been proposed for the IAFC post.

Frank Bauer presented a list of the of recommended 2-meter frequencies for use by the manned space program.

- Worldwide voice operations on MIR and ISS: Downlink: 145.80 MHz/Uplink: 144.45 and 144.47 MHz
- Worldwide packet operations on MIR and ISS: Downlink: 145.80/Uplink: 144.49
- A secondary downlink frequency of 145.84 MHz is suggested to augment 145.80 MHz. This downlink will be used for Shuttle-type vehicles (such as the U.S. Space Shuttle) and for SAREX operations.
- If a 600 kHz split pair is desired for Region 1 (Europe and South Africa) the following is suggested:Downlink: 145.80 MHz/ Uplink: 145.20 MHz

Bill Tynan noted that it should be stipulated that the 145.20 MHz uplink should not be used over North America.

Bauer noted that these frequency recommendations do not preclude simplex operations, if required. For simplex operations, the team will use frequencies which will minimize frequency contention, such as 144.45, 144.47 and 144.49 MHz.

Ray said that Hans had indicated that AMSAT-NA should coordinate all proposed SAREX/Space Station frequencies with ARRL and Region 2. Once that is done, he and the IAFC would coordinate for Regions 1 and 3. Frank indicated that he is beginning the job with ARRL and the U.S. digital community in an eventual effort to coordinate the above frequencies for manned space operations. In addition, such coordination of all non-confidential SAREX and Space Station frequencies for 10 and 15 meters and 70 cm is also beginning.

Bill Tynan noted that 145.84 MHz is not compatible with many transceivers used in Europe that tune only frequencies divisible by 25 kHz. Some of the newer ones do include 12.5 kHz steps. Tom Clark suggested that 145.838 be use in place of 145.840 and noted that people would probably not know the difference. He added that the 2-meter frequencies are necessarily a compromise between various world-wide requirements that are fundamentally incompatible.

Some comments were raised with regard to the choice of 145.80. Ray indicated that the Europeans feel that we must use it as they have coordinated repeaters off of it. On the other hand, it is only 10 kHz from 145.79 which has been adopted by the APRS people. Tom noted that the problem is that 2 meters was considered a local band and thus each area evolved its own band plans. He contended that IARU is trying to make it clear that satellites, like, weak signal/EME etc. be on a world wide band; at least the portions being used for those activities.

The document *Guidelines for the Amateur Satellite Service* was discussed next. The draft prepared by the AMSAT-NA drafting committee consisting of Art Feller, Ray Soifer, Robert Diersing, Bill Tynan and Keith Baker had been received by the IARU Satellite Advisor who has suggested several changes to make the format and language conform to common international usage.

Art Feller read a proposed re-wording of the section of the document dealing with station control. This comprised about one and a half pages. He contended that his proposed wording is necessary to bring the guidelines more in line with the U.S. rules with the goal of protecting the amateur frequency allocations. Bill Tynan stated his view that the existing wording is sufficient and to merely state that these provisions should be "in accordance with the rules of the particular country". Furthermore, he said that he hopes to work toward modification of the U.S. rules to allow for liberalizing the station control provisions as well as to allow transmission of scientific data not necessarily related to radio. He likened this to the recent liberalization of the FCC rules to permit

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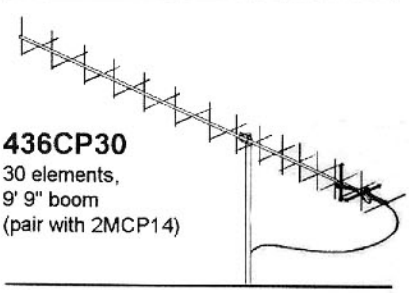
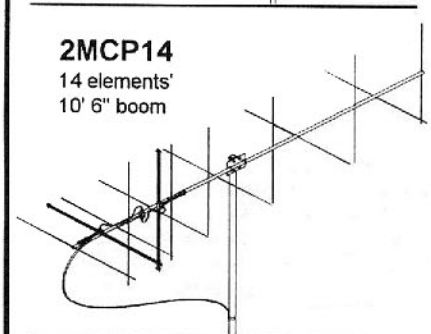
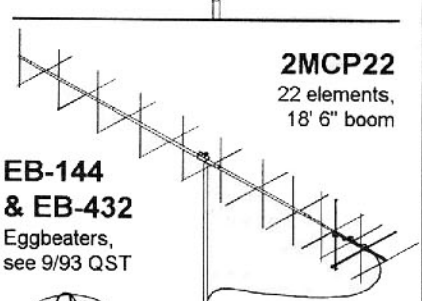


436CP30
30 elements,
9' 9" boom
(pair with 2MCP14)



2MCP14
14 elements'
10' 6" boom



2MCP22
22 elements,
18' 6" boom

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& EB-432
Eggbeaters,
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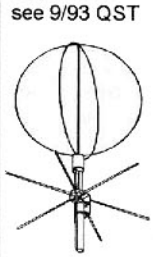

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teachers (licensed hams) in a classroom to operate amateur radio stations in the course of teaching.

Jan King was quoted as favoring rule changes to permit the downlinking of scientific data not necessarily related to radio techniques, possibly only in certain portions of the amateur bands, and probably other than 2-meters.

Ray Soifer urged that any attempt on the part of AMSAT to propose a rule change should be coordinated with appropriate ARRL people.

Tom Clark took exception to the length and complexity of the proposed Guidelines. He pointed out that the Board had approved such a simple set of guidelines at a meeting several years ago. Martha was asked to research this earlier action and post it on E-Mail [See Appendix]. Tom moved that the matter be tabled pending review of the Board's prior actions.

XV. Continuation of Long Range Plans Discussion

Keith Baker described additional possible launch opportunities including one suggested by a member of the Indian Space Agency. Ian Ashley ZL1AOX was asked to follow up on this. Tom Clark cited the interesting opportunities for launch in Russia and noted that there may again be opportunities in the U.S. for small secondary payloads to low orbits. He suggested that we anticipate the emerging trends and take a forward-looking attitude toward producing imaginative small satellites. These might include a momentum-wheel stabilized platform for a camera using GPS to mark the looking position, or using multiple small satellites linked by microwave to provide wide area coverage.

Tom submitted a motion stating that "AMSAT should encourage its members and the small satellite community to continue the development of new, low cost satellite concepts leading past the year 2000." Bill Tynan expressed his strong desire for eventually providing amateurs with access to a geostationary satellite. He said that he knows that AMSAT does not now have the capability to build a complete geostationary spacecraft but that we should be looking for ways of providing this capability, possibly by producing a package to go on someone else's satellite. In the discussion that followed Tom's motion was expanded to include goals beyond low orbiting satellites and to cover packages (as contrasted to complete spacecraft) on larger satellites in higher orbits. Keith Baker seconded the motion and it passed unanimously.

XVI. "Atta-boys" and Atta-girls

The Board acknowledged the donation by the radio amateurs of New Zealand for their contribution, and especially Fred Kennedy ZL1BYP for his excellent machining of the brackets for the P3D auxiliary battery. Mark Shephard and Ian Ashley were also thanked for bringing these to Florida. Ron Luce KD9KX was acknowledged for his help with the GPS program.

Manfred Mornhinweg XQ2FOD was thanked for the tracking software he has developed. Pat Kilroy WA8LAQ was applauded for his continuing support of AMSAT activities in the Washington, DC area. Bob Carpenter W3OTC was applauded for his continuing work with the Phase 3D fundraising database. Walt Rader WA3DMF was thanked for running the AMSAT QSL Bureau, administering the Satellite Communicators' Club award and handling orders for callsign badges. Mike Scarcella WA5TWT was thanked for serving as AMSAT Awards Manager. All the BoD members, meeting attendees and their wives were acknowledged for making the 1995 annual meeting a huge success. Martha Saragovitz was thanked for helping to arrange the details of the meeting as were the team who put it together: Mike Crisler, Bob Walker, Barry Baines WD4ASW, Hank Fitz WB4URU, Ken Quinn N4SMY and Al Brinkerhoff WB5PMR.

Tom Clark proposed a strong commendation for the TAPR organization and their volunteers for providing a useful DSP kit and software. Dick Jansson commended TAPR for their support of the Phase 3D project, financially as well as for construction of the IHU, RUDAK and GPS computer.

Lou McFadin was praised for his services to the SAREX project. Following his retirement, Lou has taken on the job of P3D Integration Manager. Matt Bordelon KC5BTL has assumed the post of SAREX Principal Investigator. Matt was thanked for taking on this challenging task.

Dick Jansson noted the generosity of the Canadians in supplying numerous small parts for the P3D project.

Bill Hook W3QBC was praised for his work transcribing the Board minutes over the past several years. Martha made the comment that his work has resulted in the best and most complete minutes we have ever had.

XIX Conclusion

The meeting was concluded at 1:30 p.m. on Monday October 9. It was not officially adjourned as various items, including the budget, are to be handled by e-mail as the need arises.

Appendix

The following was sent to the Board members by Martha via E-Mail following the meeting.

As per the BOD action item for me to find the minutes concerning guidelines for amateur satellites, the following was found in the minutes of the November 10, 1991 BOD Meeting:

"We encourage amateur scientific satellites from any source so long as they meet the following criteria:

- Data are publicly available with published formats (preferably before launch)
- There be an amateur radio operator involved and only licensed amateurs operate the control stations for these satellites
- Frequency coordination before launch with the amateur satellite community
- Notification of official bodies via IFRB filings in adequate time for comment before launch"

Moved by W3IWI, seconded by N4HY. Passed unanimously. ■

AMSAT Journal Telemetry

Still Time to Fly Your Callsign on Phase 3D

Ron Broadbent, G3AAJ reports in the October issue of the *AMSAT-UK Oscar News* that the Phase 3D callsign fund raising campaign is off to a good start. Donations have been coming in from the UK and some parts of Europe where it has been reported in two national magazines. However there have been only three donations from the United States. Ron also reports that the size and style of the engraved plaque that will ride on Phase 3D has been designed. Each donor will be provided a photograph of the plaque installed on Phase 3D that will be taken just prior to launch. Plans are underway to provide contributors who donate a significant amount to get an actual replica of the plaque. Refer to the July/August issue of *The AMSAT Journal* to learn more about this effort or contact Ron directly via telephone at 44-0818-989-6741 or e-mail r.broadbent@ee.surrey.ac.uk.

AMSAT on the Discovery Channel

As a direct result of a tip from Eric Rosenberg, WD3Q at the Dayton Hamvention last April, AMSAT was offered an opportunity to tell our story to a film crew from the *Discovery Channel*.

When it was finally declared "a wrap" on October 11, 1995 after two days of shooting, the crew had exposed over four thousand feet of 16mm film during some 86 takes. The show will be called *Eyes In The Sky*, and will be shown on the *Discovery Channel* cable channel as a two hour evening special on or about March 15, 1996 Featured on-camera spokespersons were Keith Baker, KB1SF, Dick Jansson, WD4FAB and Stan Wood, WA4NFY. In addition, a number of other familiar Phase 3D Lab faces were used in the piece.

While they wanted it to be a "fun" piece, the overall serious theme the producers were looking for from us was that *High Tech doesn't need to be High Cost.* All three of the AMSAT folks emphasized that concept...and more... in our full-face interviews. Other themes touched on included AMSAT's *KISS* approach to spacecraft design and that the paperwork needed to document the spacecraft need not weigh more than the spacecraft itself. Some time was spent discussing Amateur Radio as a whole....who hams are, and why it's important that their continued access to our frequencies be preserved. Also discussed was the spirit of adventure and commitment that's part of the glue that holds AMSAT people, and hams in general together.

Monitor the AMSAT News Service and AMSAT-BB for additional details as the *Discovery Channel* air date approaches.

UNAMSAT-B News

David Liberman, XE1TU reports that UNAMSAT-B is rapidly being made ready for flight. He says that they are looking into three possible launches but none has been signed yet. Also, they have been reviewing all UNAMSAT-B's hardware and improving a few of the circuits. Recently they received a visit from France Cordove, Chief Senior Scientist of NASA and a delegation of eight prominent scientists from NASA, including Dr. Tom Clark, W3IWI with the purpose of placing the first stone and dedicating the building which will become the Space Technology Laboratory at the Autonomous University of Mexico in Mexico City.

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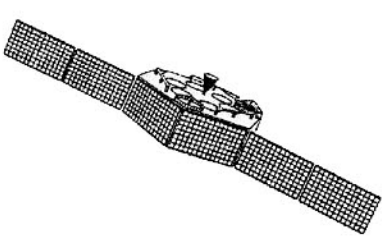

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Tracking Programs: NOVA Satellite Tracking (see above), WinTrak 3.5 Windows Tracking

OSCAR 13 Mode S Hardware: Mode S OSCAR 13 Downconverter, Mode S Parabolic 2'x3' Antenna

Rotors and Hardware: Yaesu G-5400B Az/El Rotor, Yaesu Az/El Rotor sep. kit, Emoto Rotors

OSCAR Satellite Antennas: M² 2MCP22 22 el. RHCP, M² 436CP42-U/G 42 el. RHCP, M² 2MCP14 14 el. RHCP, M² 436CP30 30 el. RHCP, M² EB-144 Eggbeater, M² EB-432 Eggbeater, M² GP for Eggbeater, KLM 2M-22C 22 el. and pol. switch, KLM 2M-14C 14 el. and pol. switch, KLM 435-18C 18 el. and pol. switch, KLM 435-40CX 40 el. and pol. switch

Crossbooms: M² Fiberglass 10 ft x 2 in (1-1/2 in. insert for G-5400B), KLM 5 ft x 1-1/2 in, 7.5 ft. x 1-1/2 in

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Publications: *OSCAR Satellite Report, Satellite Operator* Magazine, *Have Fun Getting Started on the OSCAR Satellites* Book, *Satellite Experimenters Handbook*, *Getting Started on Satellites* video, *Getting Started on Packet* video, *Basic Packet Radio* Book (everything about packet — Special price. Call!)

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